

HIS interoperability among health care centers: Case of Iran

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Abstract: Interoperability is needed at the time that hospital information system (HIS) data should be combined and shared with different systems. This study was aimed to determine the semantic and technical interoperability of hospital information systems of Iran's health care centers and propose guidelines to create and develop these centers interoperability. This descriptive study was conducted on companies, which were qualified to receive performance appraisal certificate of HIS soft wares from statistics and information technology office of health ministry. Standard questionnaire and checklist were used to collect information in the first and second steps, respectively. List of companies, which provided and produced HIS in Iran, was collected, and then a self-administered questionnaire was sent for them. Next, a health care center was selected from each company through random clustering sampling, and its current HIS interoperability was evaluated. Data were analyzed using SPSS 16. Based on the results from 15 companies, all companies were used Microsoft windows and SQL server database in their HIS with consideration to technical interoperability. Also, the most frequent corporate programming language was Visual C Sharp (46.7%) and Visual Basic (40%), respectively. From semantic interoperability aspect, the most frequent terminology systems were ICD-10(86.7%), ICD-9CM (66.7%), and CPT (66.7%), respectively. For standard messaging, 60%, 46.7% and 33.3% used XML, DICOM, and HL7 in order. Health system interoperability is divided into two semantic and technical groups. Now, there is not any standard for electronic health record (EHR) to provide full interoperability. HIS templates should be provided in order to make a national standard for EHR. Therefore, it is necessary to have standard template for semantic and technical interoperability in EHR national exchanges.

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1. Introduction

Hospital information system (HIS) is a comprehensive and integrated system, which is designed for clinical and administrative information management and includes current and related information(1). It plays a very important role in increasing care quality in hospitals as well as in health care centers(2). Hospitals, as the most important health services provider, use this technology. Information technology facilitates doing works and speeds up processes. HIS, as an aspect of this kind of technology, plays the same role in health services provision(3). Also, it is an indicator for health care developments. Health care organizations face with cost reduction and quality improvement challenges. In this regard, information systems interoperability can overcome these issues. Health care professionals often need to have a quick access to accurate information of their patients, because this information could have been recorded heterogeneously or been geographically sporadic.

Therefore, we have to consider features such as accuracy, efficiency, dependability (security), high flexibility, and error estimation tolerance while

designing interoperable HIS. Health data transformation needs same and standard structure which provides conditions for data and concepts transfer in a way that they reach to the final destination without any adverse interpret and with full confidentiality. Health care standards are aimed to enhance collection and transformation of clinical information among systems, users and organizations(4). The importance of E-health systems interoperability is increased as number of health professionals, who use computer, increases. The new challenge in health sector is to create an environment for fast and dependable information exchange among health professionals. To reach this, we have to enhance relationships and interoperability among systems(5). Interoperability is an important feature for information systems, but reaching this characteristic is not easy due to the number of system components and heterogeneity of concepts(6). Quick development of technology and its practice in health care area causes using series of non-interoperable systems in the health sector. Thus, users are forced to collect and integrate information taken from these heterogeneous systems for doing an special

practice(7). One of the most important challenges for modern health information systems is their interoperability. Therefore, the most powerful tool for an accurate medical diagnosis is having correct and timely information which a big part of this information is provided through information exchange and interoperability. Interoperability helps to share information taken from heterogeneous systems and provides answers for complicated medical questions(8). Continues development of medical science as well as its increased volume and complications, results in emergence of different branches and specialties in this area. Thus, it increases the necessity of information exchange among health care providers more than before(10). Medical information is distributed among informational systems which are heterogeneous either semantically or structurally. Making connection between hospital information systems is the most important challenge for improving health services quality and patients' health(10). In addition, health data standards are vital for exchanging health information (11). Nowadays, many of the health care providers tend to integrate operational systems with their data in order to share the information. To reach this, system interoperability with language is one of the most important problems for data and software integration due to differences in programming languages, operating systems, and database management systems. As information technology develops and people's demand for computerized medical information increases, health care organizations offer systems for management and process of a large volume of information. Hospitals and health care providers are determined to integrate their informational systems in order to exchange information and share the medical knowledge(12). System interoperability with language is the most important problem in integrating operations with data of different systems. Improvement of HIS at national level can enhance evidence-based medicine, policy-making, health programming, and public health as well as continuity of care. Access and use of interoperable information systems can increase efficiency, affordability, and quality of health systems. Also, concerns regarding interoperability, as the most important priority of health information systems, have been increased recently. Considering the importance of this issue, this study was aimed to determine the status of HIS interoperability of Iran's health care centers and, finally, propose guidelines for development and improvement of semantic and technical interoperability of HIS. and, finally,

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Methods

This descriptive study was conducted on companies, which were qualified to receive performance appraisal certificate of HIS soft wares from statistics and information technology office of health ministry. This study was carried out in three steps: in the first step, list of all companies, qualified by ministry of health, was collected. Secondly, researchers referred to the qualified companies, and data were collected from those companies using a self-administered questionnaire. For companies, which were far to access, the questionnaires were posted to their address. Content validity of questionnaire was evaluated by the help of professionals (overall, 5 experts), and its reliability was tested using test re-test and correlation coefficient ($r=0.8$). In this step, interoperability status of Iran's hospital information systems was determined based on the information given by companies. In addition, in this step, data were entered into SPSS 16 and descriptive data were analyzed using statistical methods. In the third step, list of hospitals was provided which were using HIS prepared by these companies. Then, a hospital was selected from each company using random clustering method, and data were gathered from selected hospitals by the help a checklist. In this step, the interoperability status of hospitals was determined through observation.

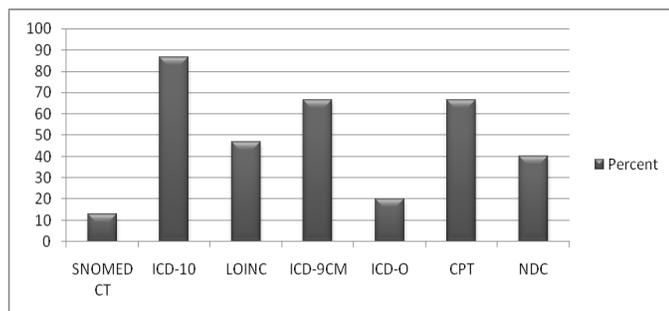
Findings

According to the findings of this study, 20 companies were qualified to receive performance appraisal certificate of HIS soft wares from statistics and information technology office of health ministry in 2012. In the second step, questionnaires were distributed among 15 companies (five companies did not participate in the study). In response to the first objective: "determining the technical interoperability status of Iran's hospital information systems"; results indicated that all of the companies used Microsoft Windows(platform) operating system, and only 13% of companies used Linux operating systems in addition to Microsoft Windows. Also, all of the companies used SQL Server database for their HIS. In addition, 6.7% of these companies benefited from Bitrive for DOS, Access, and My SQL Server in addition to SQL Server. Programming language is another aspect of technical interoperability of HIS that you can find more information in table 1 in this regard.

Table 1: Absolute and relative frequency of programming language of HIS provided by companies

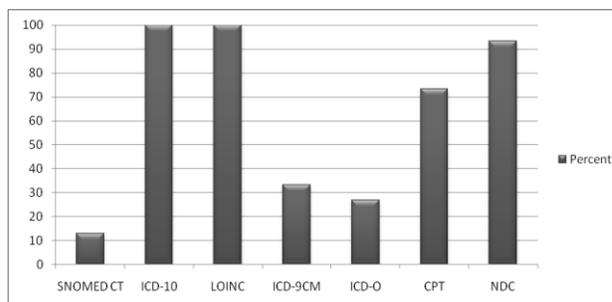
Programming language	Frequencies	Percent
Java	1	7.6
C++	3	20
C Sharp	3	20
Delphi	4	7.26
Visual Basic	6	40
Visual C Sharp	7	7.46
Visual C	2	13
Basic	1	7.6
V.BNet	1	7.6

Based on table 1, maximum relative frequency of programming language was related to Visual C Sharp (%46.7) and Visual Basic (%40) respectively, and the minimum of that was considered for Java and Basic with 6.7%. Furthermore, in response to the second objective: determining the semantic interoperability of Iran hospital information systems”, results are mentioned in the following. Terminology system which is used in HIS is shown in graph 1 based on the responses given by companies.



Graph 1: Relative frequency of terminology system used in HIS based on the responses given by companies

As shown in graph 1, the highest relative frequency for terminology system is related to ICD-10 (%86.7), ICD-9CM (%66.7) and CPT (66.7%), respectively, and the lowest of that was for SNOMED CT (%13). Moreover, findings of this study indicated that 60% of companies used XML, 46.7% used DICOM, and 33.3% benefited from HL7 standard for standard messaging in their HIS. In consideration to “content and structure standard of HIS” aspect, 20% of companies used OpenEHR and 20% benefited from 13606 HER.COM standards. Regarding standards of privacy and security in hospital information systems, only 13% utilized ISO 27000, and 6.7% benefited from HL7, RC4, FISMA, as well as ISO TC215. In third step of study, data were collected only about terminology of HIS due to weak participation of companies (graph 2).



Graph 2: Relative frequency of terminology system of HIS based on the researcher observations

Conclusion

World web is changing the way medical services and researches are going on. In the future, standard medical databases and integrated practical medical programs, such as clinical decision-making support systems, will be used in medical area. XML will increase sharing clinical data among users. The important property of this system is providing the portability of data through displaying data separately from their contents. XML works well when it is aimed to exchange data from a software to other soft wares through communicational channels like internet. This technology helps doctors to share the clinical data while making complicated and vital decisions(13). Semantic interoperability is needed when HIS data should be taken from different systems and shared among them. It aims at making semantic relationship, especially among clinical data. These systems should be based on an architectural model in order to provide interoperability among hospital information systems. Systems’ architecture is defined by its structure and behavioral aspects of its components. This architecture should be led by available business processes and services. Therefore, designing, implementation and maintenance method for semantic interoperability of health information system is a service-oriented architecture (SOA). Currently, HL7 is moving from a message-based pattern towards an architecture-based approach(14). This article clarified the main reasons for having interoperability, and described clinical terminology to reach that. As mentioned in the findings, different hospital information systems are produced and used in Iran. Health care system interoperability can be divided into two dimensions including technical (operational) and semantic interoperability. Now, there exists no EHR standard to provide full interoperability. In order to create a national EHR standard, series of HIS templates should be developed. Therefore, it is necessary to have a standard format for national EHR exchange. This template need to be included an architecture of forms, components and parts. Designing a basic and fundamental template for a standard development

and stabilization provides document-based information as well as information interoperability infrastructure for HIS. Efforts done to record information, coded data in clinical records and health electronic messages are important for supporting clinical systems interoperability and declining medical errors caused by misinterpretation and inappropriate data. Clinical systems interoperability needs integration of standard data models such as HL7 messages or open EHR archetype along with terminologies like SNOMED-CT(15). Many studies (16) have discussed about health systems interoperability and clarified its different aspects as well as mentioning it as an important health sector challenge. Rodriguez et al. counted on ontological language used in informational system as a way to relate and interoperate different terminologies. Current development in health sector indicates emergence of new informational systems, which use semantic and ontological structure for proposing an infrastructure to implement multi-dimensional objectives, interaction with different terminologies and EHR. These new developments change informational systems from just being a uni-dimensional tool towards clinical decision-making support tools as well as research tool for health professionals and users.

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