

# Evaluation of key capabilities for hospital information system: A milestone for meaningful use of information technology

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## ABSTRACT

**Objective:** In line with socio-technical approach, evaluation of successful adoption of hospital information systems (HISs) is associated with several factors including operational, organizational, technical, managerial, legal, and social factors. This study attempts to evaluate these systems in five areas of technical, functionality, usability, and vendors' capabilities, and care quality provided by HIS vendors. **Materials and Methods:** Through a cross-sectional study, the key HIS capabilities were evaluated in Iran. The key capabilities/requirements for HIS were specified by expert panel focus group meeting through the idea webbing and review of related literature. Modified Delphi technique was employed to collect and analyze data. The expert panels express their view on each of the HIS key capabilities on a 5-point scale from "strongly agree" to "strongly disagree." Checklist was designed based on expert panels' viewpoints and employed for evaluating HIS capabilities. **Results:** Technical requirements with 68.3% and vendors' capability requirements scored the highest marks (68%) while improved quality of patient care requirements scored the lowest mark (24.8%). Functional requirement of the studied eight departments showed that financial department scored the highest (71.6%) while nutrition department scored the lowest marks (22.8%). Results on the evaluation of technical requirements showed that response time scored the highest (75%) while communication services scored the lowest marks (59.7%). **Conclusion:** The favorable status of Iran's HISs in technical area, their poor performance on the requirements of quality patient care place emphasis on financial and reimbursement objective, and neglect of Systemized Nomenclature of Medicine-Clinical Terms as a basis to support quality of patient care requirements endorse the fact that Iran's current HIS is still in its infancy. To narrow the variability and diversity in structure and requirements of HIS vendors, reducing the gap between required and adopted HIS functions, and moving toward "meaningful use of HIS," well-organized actions at the level of Iran Ministry of Health appear essential.

**Key words:** Benchmarking, commerce, hospital information systems, meaningful use

## Introduction

Hospital information system (HIS) supports functional requirements of users in terms of data management, collection, storage, processing, and exchange.<sup>[1]</sup> Health-care ISs are considered a tool for improving efficiency and efficacy, and reducing the cost of care.<sup>[2-5]</sup> Accordingly, adoption rate of ISs is on the rise

in health-care system.<sup>[6]</sup> The growth rate is estimated at 6.6% in European countries, Africa, and Latin America, 7.6% in Asia Pacific region, and 9.7% in North America.<sup>[7]</sup> In some aspects of information and communications technology (ICT), the growth rate is anticipated to reach 85% by 2014.<sup>[6]</sup> However, the design and development

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of ISs is highly expensive.<sup>[8]</sup> Evidence shows that nearly 2.6%–6% of health budget is allocated to ICT.<sup>[9]</sup> The overall market for such systems is increasing from \$15.5 billion in 2010 to \$19.7 billion in the coming years.<sup>[7]</sup> Despite the growing use of ISs, positive results from implementation of such tools in health care are still vague.<sup>[8]</sup> Investigations suggest that ISs have been unsuccessful in meeting the demands and requirements of clinical processes for which they were designed.<sup>[10]</sup> Whereas HISs among organizations are developed by a vast and diverse range of users and beneficiaries and their success is associated with several factors including operational, organizational, technical, managerial, legal, and social factors.<sup>[11-14]</sup> In this context, studies indicate doctors' concern about the technical aspects of ISs including security and confidentiality of information, which is considered one of the reasons for their failure.<sup>[15]</sup> Nonetheless, usability is one of the reasons for their success.<sup>[16-18]</sup> In terms of social aspects, successful implementation of an IS depends on users' attitude and satisfaction.<sup>[19]</sup> Thus, design and implementation of ISs is a difficult process which often fails.<sup>[11]</sup> A study in America showed that more than half of the IS design projects fail and 70% of them fail to satisfy users.<sup>[20]</sup> A study conducted in 2007 on 217 information technology projects showed that, in 35% of cases, failures were due to neglecting technical requirements.<sup>[21]</sup> In addition to imposing heavy costs on organizations, failure of these systems adversely affects patient care and staff and is considered as "social leprosy."<sup>[22]</sup> Therefore, careful assessment of ISs forms an inseparable part of successful implementation of these tools. Whereas ISs are an integral part of organizational structure and processes, and it is necessary to address technical, human, organizational, and user interface issues of these systems.<sup>[23,24]</sup> Thus, careful assessment of ISs requires something beyond primary and technical aspects but should be performed with an emphasis on socio-technical approach<sup>[25]</sup> and providing organizational objectives and users' expectations in terms of assessment of requirements and capabilities of HISs. Results of such assessments can ensure success of ISs and also help organizations choose the right system appropriate to their users' needs and work processes. They can also identify the strengths and weaknesses of ISs, provide the possibility of comparison and benchmarking different vendors, and provide the context for improving design and development of these systems according to standard capabilities and requirements.<sup>[9,26]</sup> In line with socio-technical evaluation of HISs, this study attempts to evaluate these systems in five areas of technical, functionality, usability, and vendors' capabilities, and care quality provided by HIS vendors.

## Materials and Methods

### Setting

This descriptive cross-sectional study was conducted in 2013. The study setting comprised public and private hospitals in Iran and the study population consisted of HIS vendors.

### Determining the main capabilities/requirements of hospital information systems

#### Holding a specialized meeting with experts

At this stage, a panel of experts was formed consisting of 25 users and designers of HIS. This meeting was held with the aim to identify every aspect associated with HIS in the context of hospital, irrespective of the study objectives. Brainstorming was applied to identify aspects associated with HIS and to collect ideas, and idea webbing techniques were used to organize ideas [Figure 1]. At this stage, aspects and features associated with HIS were categorized into two groups of inherent features of HIS and health-care enterprise features. Inherent features of HIS address issues associated with hardware and software components and implementation and health-care enterprise features related to organization, its users, and its processes. Following identification of important aspects in view of users and designers of HIS, the second stage of the study was conducted as a review of relevant literature to factors affecting satisfaction and success of ISs.

### Review of literature and classification of ideas

This stage was conducted as library research, and relevant articles were collected and examined in a nonsystematic method

- The DeLone and McLean (D and M) model of IS including model of IS success, Human Organization and Technology-fit (HOT-fit), Technology Acceptance Model (TAM), Expectation–Confirmation model, and Task Technology Fit (TTF)<sup>[27-31]</sup>
- Factors affecting users' satisfaction
- Operational aspects and functional capabilities of ISs<sup>[32-37]</sup>
- Barriers to implementation of ISs.

### Summarizing and categorizing information to determine functional capabilities of hospital information system

At this stage, experts' ideas were re-classified according to information found in review of literature. Figure 1 shows classification of information and the relationship between two stages. Table 1 presents the details of participating experts in focus group meeting.

In Figure 1, cases outside the rectangle form the final areas of capabilities and requirements of HIS, which

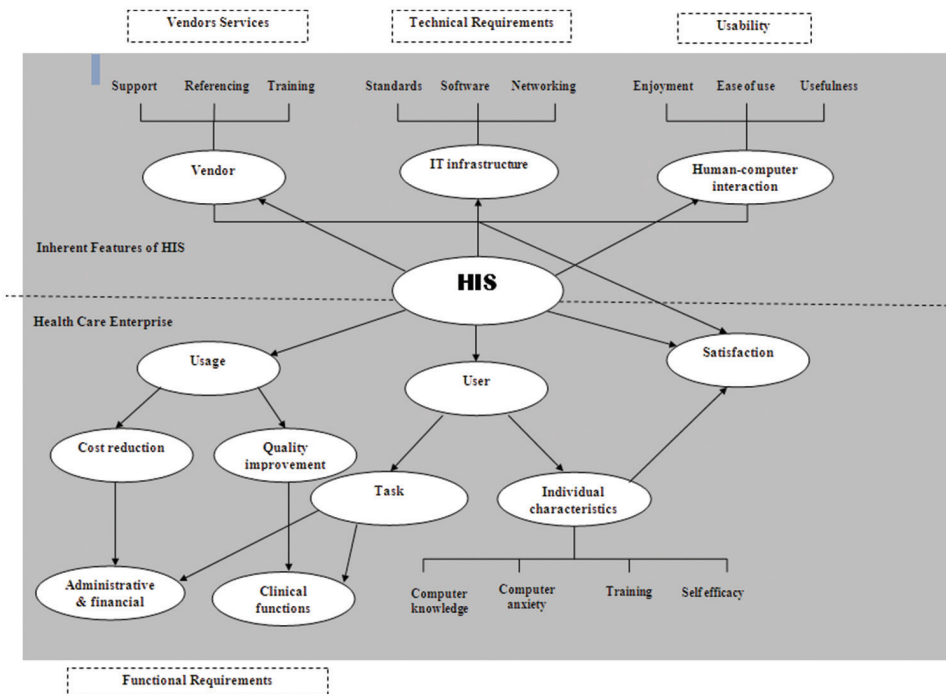


Figure 1: Concepts and aspects associated with hospital information system according to experts' comments

Table 1: Details of participants in focus group meeting

Job category	Job responsibilities	Number of participants
IT administrator	IT administration/IT support services	6
Health information management	Management of information and medical record	3
Nurses	Health-care provider	3
Physicians	Health-care provider	3
Management	Management and administration services	5
Ancillary staff	Staff of laboratory, radiology, pharmacy departments	5
Total		25

IT=Information technology

have been classified according to the summary into five main areas of technical, usability, care quality, vendor services and capabilities, and functional features. Other aspects associated with user characteristics including computer literacy, computer anxiety, and computer self-efficacy were not considered in this study because of irrelevance to inherent HIS capabilities. Focus group meeting was held to agree upon a main framework for the assessment of five areas of HIS capabilities, and a consensus of panel of experts was reached using modified Delphi method. For this, the results of the first and second phases are provided in Figure 2 and examined through the modified Delphi technique. Focus group was conducted under the supervision of trained moderator (researcher) during 2 h meeting. The data were transcribed and entered into NUD\*IST,

a qualitative data software package. A preliminary questionnaire was designed based on qualitative data analysis of HIS capabilities. The expert panels express their views on each of the HIS key capabilities on a 5-point scale from “strongly agree” to “strongly disagree,” and consensus was set a level of 70% for each requirement. Figure 2 shows all primary and secondary areas of main capabilities of HIS.

Data sampling and collection

First, a list of all HIS vendors was prepared, and 19 vendors with a minimum of 5 years of experience in software implementation in hospitals were selected. Considering operational software programs in hospitals, one hospital was selected using convenient random method from among hospitals implementing each software. A total of 19 hospitals were determined throughout Iran and the final checklist was designed based on the five main HIS areas to collect the data vendors' key capabilities [Figure 2].<sup>[26,32-40]</sup> A trained person was appointed to collect data throughout the 19 hospitals.

Analysis of data

Data were analyzed using descriptive statistics, with Statistical Package for the Social Sciences (SPSS) software by IBM, USA. A yes/no scale was used for scoring software programs so that the presence of a scale scored 1 and its absence scored 0. After assessment and scoring of questions in each area, results of assessment of HIS capabilities were classified in five levels: 0–20 as

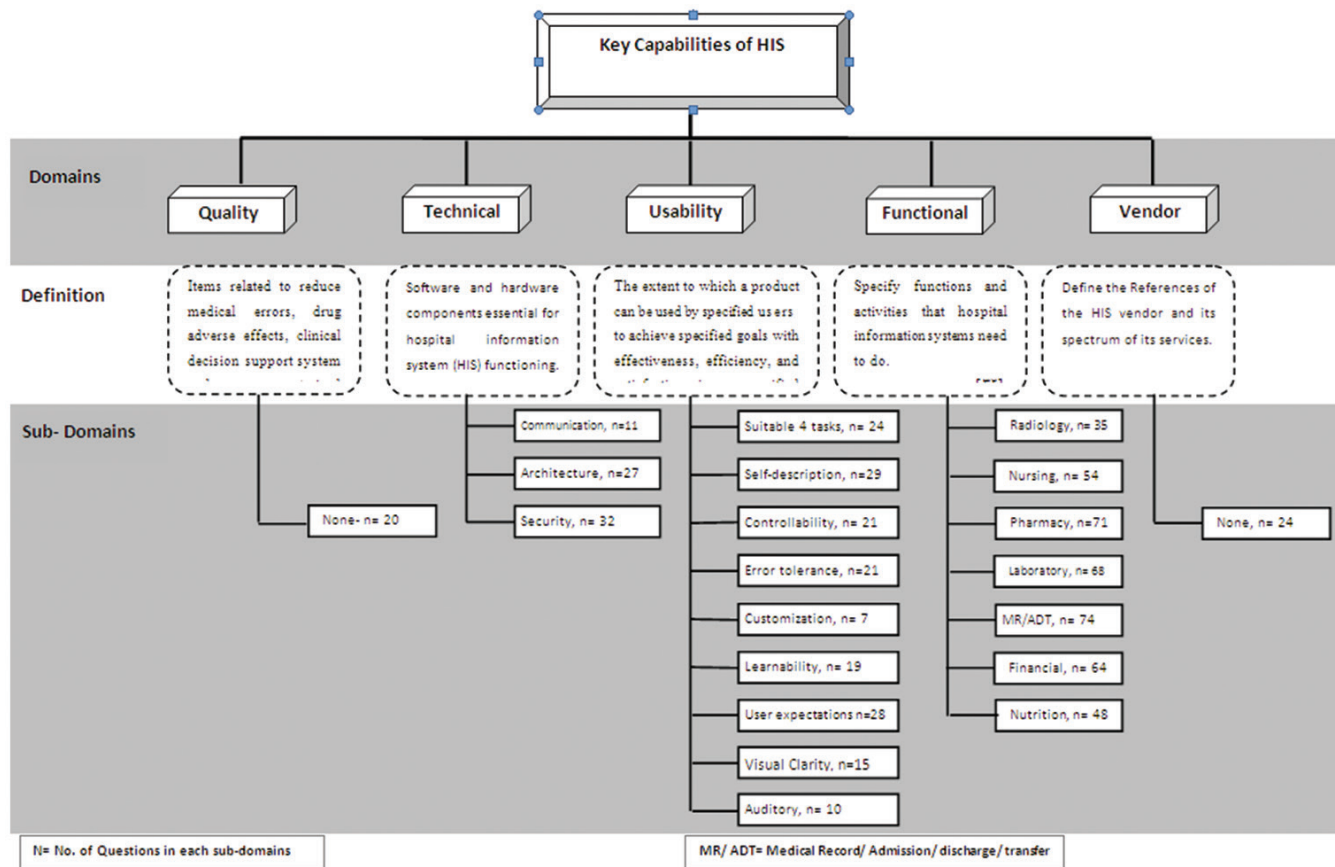


Figure 2: Hospital information system’s capabilities after summarizing experts’ information and review of literature

very poor, 20–40 as poor, 40–60 as medium, 60–80 as good, and 80–100 as very good.

### Results

The results showed that HIS key capabilities scored 57.7 in total. Among the requirements studied, technical requirements with 68.3% and vendors’ capability requirements scored the highest marks (68%), and improved quality of patient care requirements scored the lowest mark (24.8%) [Table 2].

The results on the study about functional requirements showed that, of the eight departments studied, functional requirements of financial department including creating standard and *ad hoc* reports for financial decision-making, automatic generation of administrative and financial data from clinical record, rules-driven financial and administrative coding assistance, and capturing the episode and encountering information to pass to administrative or financial processes scored the highest (71.6%), and functional requirements of nutrition department including documentation of nutritional regimens, recommendations about nutrition, entry of nutritional status based on patient’s clinical and physiologic

data (e.g., weight, appetite, and activity), etc., scored the lowest marks (22.8%) [Table 3].

Based on the results of technical requirements’ evaluation, “response time” including processing time and response time to users request scored the highest (75%), and “communication services” including using content and data exchange standards, e.g., HL7, ISO13606, DICOM and electronic communication scored the lowest marks (59.7%) [Table 4].

### Discussion

This study was conducted with the aim to assess HIS capabilities in five areas of technical, usability, care quality, vendor services, and functionality in Iran. Results obtained favorable performance in technical requirements. Technical aspects were one of the first causes of HIS failures in the early 1970s to mid-1980s.<sup>[41]</sup> Accordingly, the role of technical factors has been emphasized in many studies on the success and failure of ISs.<sup>[42]</sup> In many recent studies, technical aspects were also considered as one of the important criteria in ISs. In a study by Brender (2006) aiming to determine the causes of success and failure of HIS, technical aspects were also identified as an important



factor in the success of ISs. In their study, Hubner-Bloder (2009) to determine the main capabilities of HIS considered three aspects of technical quality, software quality, and architecture and interface quality.<sup>[26]</sup> Many studies attribute sluggish and delayed growth of electronic health record (EHR) systems in health care to technical barriers and inappropriate design elements. Thus, accounting for technical aspects of ISs is considered an important capability in the assessment of these systems.<sup>[43-45]</sup> this study results showed that requirements of vendor companies was another favorable aspect in HIS assessment. The

**Table 2: Evaluation scores of hospital information system's key capabilities/requirements**

Requirements	Presence/absence of requirements			Total, n (%)
	Yes, n (%)	No, n (%)	No response, n (%)	
Functional	3847 (55.2)	2447 (35.1)	681 (9.8)	6975 (100)
Technical	842 (68.3)	339 (27.5)	51 (4.1)	1232 (100)
Usability	1730 (61.8)	987 (35.3)	83 (3)	2800 (100)
Support for quality of care	80 (24.8)	231 (71.7)	11 (3.4)	322 (100)
Capabilities and services of HIS vendor	261 (68)	81 (21.1)	42 (10.9)	384 (100)
Total	6760 (57.7)	4085 (34.9)	868 (7.4)	11,713 (100)

HIS=Hospital information system

**Table 3: Evaluation scores of hospital information system's functional requirements**

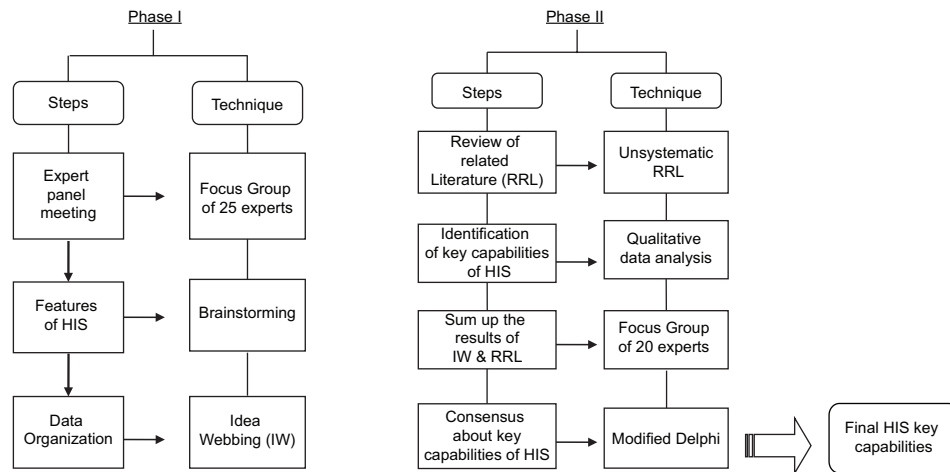
HIS functional requirements	Presence/absence of requirements			Total, n (%)
	Yes, n (%)	No, n (%)	No response, n (%)	
Radiology	339 (60.5)	203 (36.3)	18 (3.2)	560 (100)
Nursing	345 (39.9)	491 (56.8)	28 (3.2)	864 (100)
Pharmacy	672 (58.3)	400 (34.7)	80 (6.9)	1152 (100)
Laboratory	640 (58.8)	328 (30.1)	120 (11)	1088 (100)
Admission and medical records	808 (68.2)	315 (26.6)	61 (5.2)	1184 (100)
Financial	739 (71.6)	262 (25.4)	22 (2.1)	1023 (100)
Nutrition	175 (22.8)	300 (39.1)	293 (38.2)	768 (100)
Outpatient/clinic	129 (38.4)	148 (4)	59 (17.6)	336 (100)
Total	3847 (55.2)	2447 (35.1)	681 (9.8)	6975 (100)

HIS=Hospital information system

**Table 4: Evaluation scores of hospital information system's technical requirements**

Technical requirements	Presence/absence of requirements			Total, n (%)
	Yes, n (%)	No, n (%)	No response, n (%)	
Communication services	105 (59.7)	65 (36.9)	6 (3.4)	176 (100)
System architecture	284 (65.7)	132 (30.6)	16 (3.7)	432 (100)
Security services	369 (72.1)	115 (22.5)	28 (5.5)	512 (100)
Response time	84 (75)	27 (24.1)	1 (0.9)	112 (100)
Total	842 (68.3)	339 (27.5)	51 (4.1)	1232 (100)

growing trend of using HIS has created a competitive atmosphere among HIS vendors, and the role and services provided by vendors are considered a key factor in the success of these systems.<sup>[46]</sup> [Figure 3] Services provided by vendors, from training users to operation support and bug fixing management, emphasize vendors' role change from nonmember to stakeholders.<sup>[47,48]</sup> Today, vendor's service support role has been proven in the successful implementation of ISs and greater satisfaction of users in health care.<sup>[49]</sup> Studies indicate that quality of services provided by IT software vendors affects users' satisfaction with ISs.<sup>[50-52]</sup> Accordingly, the role of IT support is considered in the construct of many successful IS models including D and M,<sup>[27]</sup> HOT-fit,<sup>[29]</sup> TAM,<sup>[28]</sup> and TTF.<sup>[30]</sup> According to evidence, the quality of IT services affects perceived ease of use, perceived efficiency, and users' satisfaction with these systems.<sup>[19,28]</sup> Thus, close collaboration and interaction of users with IT team, both inside and outside organization, will ensure successful implementation of ISs in health care, and how these services are provided should be assessed as a capability of HIS.<sup>[53]</sup> This study results indicated an unfavorable status of HIS in the requirements of improved quality of patient care. Yet, improved quality of care is among the ultimate goals of health-care ISs.<sup>[2-4]</sup> Yoo (2013) revealed that enhanced ISs' capabilities in line with improved quality of care and patient safety are considered among the main priorities of all health-care professionals.<sup>[54]</sup> Previous literature indicated that 84% of EHR adopters of use of EHR can provide clinical benefits for patients and 71% believe that it can help improve patient care.<sup>[55]</sup> In Australia, more than 90% of general practitioners use computerized clinical packages which support functions associated with patient safety including medication safety and drug-drug interactions.<sup>[56]</sup> Many studies showed that use of these systems has played an effective role in reducing medication errors and improving patient care. Computerized physicians order entry (CPOE) is another system that can improve patient care.<sup>[57-58]</sup> Doctors and nurses believe that CPOE can affect efficacy, clinical processes, and drug safety.<sup>[59]</sup> In fact, HIS can play a highly effective role in improving patient care through equipping with CPOE and clinical decision support systems (CDSSs).<sup>[60]</sup> Many physicians believed that improved quality of care in ISs can be realized through CDSSs.<sup>[61]</sup> However, the use of CDSSs is subject to use of clinical terminologies.<sup>[62]</sup> Use of data exchange standards and standard terminologies such as Systemized Nomenclature of Medicine-Clinical Terms (SNOMED-CT) and International Classification of Disease (ICD) is considered an essential infrastructure in electronic systems.<sup>[63]</sup> Results of the current study showed that all systems studied in communication areas were only equipped with administrative



**Figure 3:** Research design and steps

terminology such as ICD which rather deals with disease management, reimbursement, monitoring of incidence and prevalence of diseases, and health-care policymaking. Yet, SNOMED-CT is used in more than fifty countries as the basic standard in electronic medical record (EMR)/EHR design.<sup>[64]</sup> In addition to sharing and reuse of data such as retrieval of clinical findings, improved perceived patient care and access to information sources of patient care SNOMED-CT also play a vital role in the application of expert systems. Although studies conducted in US confirm that currently SNOMED-CT is only implemented in 33% of EMR/EHR.<sup>[65]</sup> Aspects of patient care quality should address through functional capabilities of various units of nursing, radiology, pharmacy, and laboratory. However, results of studies conducted in Iran confirm that IS capabilities less focus on the requirements that support quality of care.

## Conclusion

The favorable status of Iran's Health Information Systems in technical area as an elementary factor in the success of ISs, their poor performance in requirements of quality of patient care, and application of administrative terminologies to provide financial and reimbursement goals such as ICD, alienation of these systems with SNOMED-CT as the professional system infrastructure, and improved quality of patient care are indicative of the fact that Iran's current HIS still emphasizes on the primary goals of HIS. Variability and diversity in structure and requirements of HIS vendors are among the challenges to the future development of these systems. Thus, to move toward next generation of HIS, with emphasis on quality of care, helping care organizations in selecting and evaluating quality of HIS, reducing the gap between required and adopted HIS functions, and moving toward "meaningful use of

HIS," the following actions are essential:

1. Deciding priorities and objectives of HIS, including improved quality of patient safety and care, increased efficacy and access to services, and countrywide patient-oriented participation by the Ministry of Health
2. Determining requirements and capabilities of HIS to realize the above objectives
3. Staging and determining realization of requirements of HIS in every stage
4. Assessing and accrediting the existing nationwide ISs according to predetermined requirements
5. Providing feedback to HIS vendors to reduce variability in performance, and issuing certificates to authorized vendors based on the Ministry of Health requirements.

### Clinical relevance statement

- Iranians' HIS capabilities are restricted to technical requirements and neglect requirements for quality of patient care
- There is variability and diversity in structure and requirements of HIS vendors
- Narrowing the gap between required and adopted HIS functions, and "meaningful use of HIS," necessitates intervention of Iran Ministry of Health.

### Protection of human and animal subjects

The study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects, and was reviewed by Institutional Ethics Review Board [Ethics code 4266- 6-2-2013].

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### Conflicts of interest

There are no conflicts of interest.

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