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ORIGINAL PAPER

Evaluating the Ability of Hospital Information Systems to Establish Evidence-Based Medicine in Iran

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Abstract Evidence-based medicine (EBM) is the correct use of the best evidences in clinical decision making for patient care. Hospital Information Systems (HIS) can act as a bridge between medical data and medical knowledge through context-sensitive merging and filtering of patient data, individual clinical knowledge and external evidence. The aim of this study was to determine the ability of HISs to establish EBM in Iran. This descriptive cross-sectional study was carried out on HISs of 30 hospitals from March 2011 to October 2011. Data were collected using a researcher-constructed checklist including applicant's background information as well as information based on research objectives: clinical decision support system (CDSS), reference databases, contextual and case-specific information, clinical and administrative data repositories and Internet-based health information. Face and content validity of the checklist were assessed by the qualified specialists and then the data were analyzed using descriptive statistics and SPSS 16 software. The results of the study revealed that the HISs lacked the essential components to providing access to CDSS, reference databases and Internet-based health information in 19, 16 and 20 hospitals were 63.3 %, 53.3 % and 66.7, respectively. Twenty-two hospitals (70 %) had more than two-thirds of the essential components to access clinical and administrative data repositories; 23 hospitals (76.7 %) had at least one essential component to access contextual and case-specific information. It can be concluded that the ability of the HISs to establish EBM in providing access to the clinical and administrative data repositories is better than other research objectives. Furthermore, more attention should be paid to other related objectives.

Keywords Clinical decision support system · Clinical and administrative data repositories · Contextual and case-specific information · Evidence-based medicine · Hospital information system · Reference database

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Introduction

Evidence-based medicine (EBM) is the correct and judicious use of the best evidence in making clinical decisions about the care of individual patients. [1] The best evidence is used in determining the best clinical practice, health services and management decisions. [2] The history of EBM goes back to 1976 when Dr. Garden Guit and his colleagues in McMaster University (Canada) introduced a modern approach (EBM) for training physicians [3–5]. Some reasons that signify the need for establishment of EBM were morbidity and mortality from medical errors, [2, 5–7], physicians' knowledge have not been updated after graduation, physicians unanswered questions in the field of treatment, the physicians do not have the ability to assess the information correctly and to separate valid information from invalid one, physicians should spend a long time to find new information and also different treatment methods are used by physicians to treat a

particular disease; [3, 5, 8–11] one of the most important obstacles in getting the important clinical information is the lack of enough time for updating the information, so that, a medical student, a resident and a university professor have spent 120, 45 and 30 minutes time to study per week respectively. [4] Another important obstacle is that physicians only access to old information and irregular scientific texts. [12] EBM is being presented through six application areas: reference database, contextual and case-specific information, clinical and administrative data repositories, clinical decision support system (CDSS) and Internet-based health information. [2, 13, 14] Considering the existing obstacles to providing access to EBM, using hospital information system (HIS), as a new method for obviating the obstacles, [15] can pave the way to develop EBM and can function as a bridge between medical data and medical knowledge through merging of patients' data, physicians' medical knowledge and the best external evidence. [9, 16] HISs were used to collect, store, process and retrieve of the data (especially the medical records information) which were coherently stored in databases and applicants had access to it, in a correct time and place and in a form that was compatible to the need of applicants [17]. To make successful clinical decisions in EBM, having access to different information including existing clinical data, primary data of patients and scientific evidence is required. Easy access to the clinical knowledge was possible through providing the clinical guidelines, the guideline is necessary to transfer information but not sufficient. Moreover, using the information technologies is vital to access to the clinical information. Expert CDSSs in HIS can transfer this Knowledge. By connecting the HIS with database and digital library, the automatic connection of clinical data and knowledge-based information (e.g. patients' record, biomedical articles and real databases) can be put together. [18] Some studies show that by using EBM, costs of prescribing drugs are being reduced to 12 %, duplications of work can be avoided and also the physicians who use HIS have 30 % more income than the others[2]. The ultimate goal of using HIS in EBM is to connect patients' electronic medical information to electronic information in digital library.[18] This connection provide the beneficial use in determining the kind of disease, the easy access to scientific evidence, the accepted curative functions and other tools for supporting decisions. [19] On the other hand, HIS should support logical information in a hospital and provide this information to applicants in a convenient way and in a correct time and place. [16] The aim of this research is to determine the ability of HIS to establish EBM in hospitals in Iran.

Materials and methods

This descriptive cross-sectional study was conducted from March 2011 to October 2011. The study population was HIS softwares applied in hospitals of Iran by software company producers; this software consisted of the following parts in accordance with EBM, as objectives of this study:

Clinical decision support system: Clinical decision software applications are designed to support the analysis of patient data and to automate aspects of clinical decision-making that can be expressed as explicit and reproducible rules that are built and maintained by a database of guidelines.

Reference database: data obtained from basic investigative and clinical observation are made available with other relevant information of the biomedical literature (books and periodicals), the formal publications of clinical trials and reviews, and the records of current research.

Contextual and case-specific information: historically and pragmatically, on a regular basis medical and nursing practitioners make use of unreviewed and unvalidated sources of "soft" data and evidence as the basis for their decision-making; they can be categorized as contextual and case-specific sources.

Contextual information refers to environmental, socioeconomic, and epidemiological factors for a particular site and time.

Case-specific information is the accumulated data on current and past encounters with the health care system; often voluminous, it is represented by the clinical and administrative data registered.

Clinical and administrative data repositories: data fragmentation, lack of structure, incompatible terminologies, the separation of clinical from financial and administrative data, and the break-up of patient data over time and space all prevent the use of the wealth of data already stored in non-automated medical and administrative records. Therefore, clinical administrative data repositories consist of available data in EHR and other systems to support the reorganization of the analysis.

Internet-based health information: the growing area of interactive health communication (IHC) is defined as "the interaction of an individual consumer, patient, care-giver, or professional, with or through an electronic device or communication technology to access or transmit health information or to receive guidance and support on a health-related issue". Sample selection, through investigating articles and references, revealed that 15 computer companies including Tarahane Booali, Peyvand Dadeha, Rayavaran, Rahavard Rayaneh, Teb va Rayaneh, Tirazhe Rayaneh, Tarasheh Hooshmand,

Table 1 Frequency distribution of the ability of his to establish EBM in providing access to CDSS

Ability	Item	Had	Did not have
1. CDSS for drug interaction		3 (10)	27(90)
2. CDSS to offer the appropriate treatment		2(6.7)	28(93.3)
3. CDSS to choose the drug dose		3(10)	27(90)
4. CDSS for the time of consuming medicines		3(10)	27(90)
5. CDSS for medicinal suggestions		5(16.7)	25(83.3)
6. CDSS for the quantity of the consumed drugs		5(16.7)	25(83.3)
7. CDSS for alternative drugs		3(10)	27(90)
8. CDSS for laboratory test		8(26.7)	22(73.3)
9. CDSS for radiology test		5(16.7)	25(83.3)
10. CDSS for other care services		2(6.7)	28(93.3)

Micro Afzar Gheshm, Tarrah Dade Pishro, Sayan Rayan Ekbatane Hamedan, Hospital Information System of Mashhad University of Medical Sciences, Pooya Samaneh Diva Mazandaran, Samen Salamat, Pooyesh Pardazesh and Tamin work in Iran [20–22]. Considering that each HIS software producer company applies the same software in the hospitals (Tehran and other cities of Iran), 2 hospitals were participated in the study from each company (totally 30 hospitals). Regarding the time and place limitations in the study and using the same software in each company, priority choice was assigned to Tehran hospitals and only if a company was not applied its software in Tehran, other cities had entered into the sampling. Data were collected using a two-part checklist containing background information of the hospitals and questions related to the research objectives through observing the HISs in the hospitals. Both facial and content validities of the checklist were confirmed by the specialists, that is, by studying some references the first draft of a checklist was prepared and reviewed by 4 faculty members of the Department of Management and Health Information Technology, Kashan University of Medical Sciences. Then based on their suggestions, which were collected during the three sessions, the checklist was developed and piloted in HISs of 3 hospitals and based on the obtained data, the final checklist was prepared. Data were analyzed using descriptive statistics and SPSS 16 software.

Results

Results of this study showed that HISs were implemented in 27 hospitals (90 %) and in other hospitals were run in pilot stage. Executive program of HISs was run under the Windows in 22 hospitals (73.3 %) and under the Web (20 %) or Dos (6.7 %) in other hospitals. The HIS was active in each ward in 28 hospitals (93.33 %), physicians had complete access to HIS in 19 hospitals (63.33 %) and they had been trained enough to use HIS in 5 hospitals (16.67 %).

Moreover, results showed that HIS in 19 hospitals (63.3 %) does not have essential components to establish EBM regarding providing access to CDSS. In 2 hospitals (6.7 %), HIS had the ability to suggest an appropriate treatment and in 8 hospitals (26.7 %), HIS had the ability to support laboratory orders using CDSS (Table 1).

Results showed that 20 hospitals (70 %) had more than two-thirds essential components to establish EBM by providing access to clinical and administrative data repositories. Thirty hospitals (100 %) also had the ability to record the quantitative information in radiology (Figs. 1, 2, and 3).

Fifteen hospitals (50 %) had the ability to record the results of consultation (Table 2).

Furthermore, 16 (53.3 %) hospitals lacked the essential components to establish EBM in terms of providing access to scientific papers by using reference databases and 20 hospitals lacked (66.7 %) the essential components to establish EBM in terms of providing access to Internet-based health information. One hospital (3.3 %) had the ability to

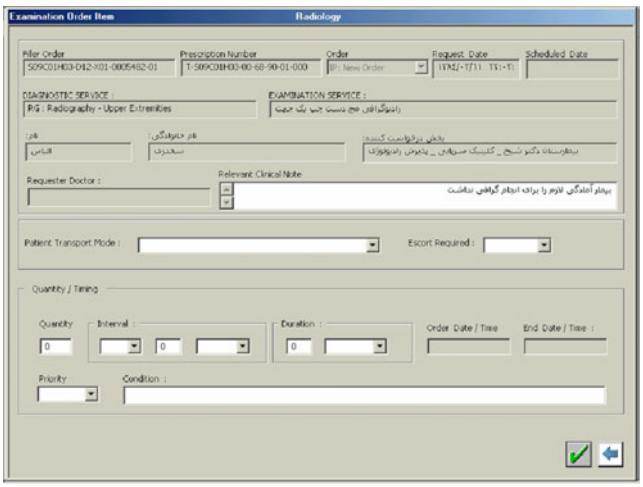

Fig. 1 Demo of the examination order items for radiology

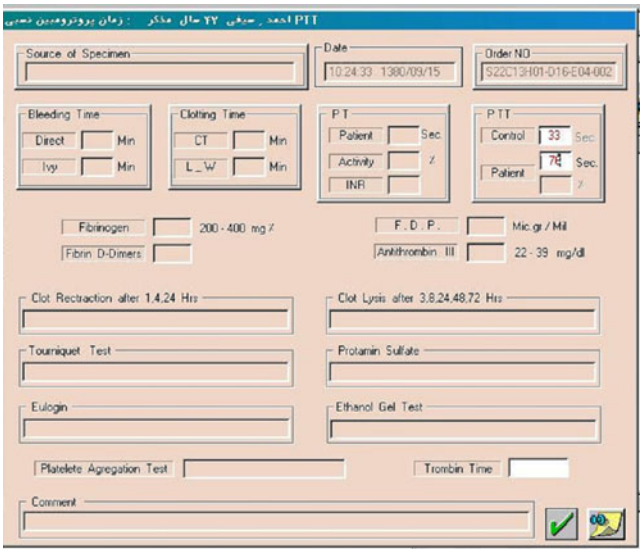

Fig. 2 Demo of the examination report for laboratory

receive information through Medline; 8 hospitals (26.7 %) the ability to connect to the university website and 6 hospitals (20 %) the ability to connect to the digital library.

In terms of providing access to contextual and case-specific information, Twenty-third hospitals (76.7 %) had at least one essential component to establish EBM. Also, there was a disease-specific base in 8 hospitals (26.7 %), and it was possible to retrieve patients' lists with the same disease in 23 hospitals (76.7 %) (Table 3).

Discussion

This cross-sectional study revealed that among a total of HISs implemented in Iran, the HISs in 7 hospitals (6.7 %) had the ability to suggest the appropriate treatment, and in 8 hospitals (26.7 %) the ability to support laboratory orders.

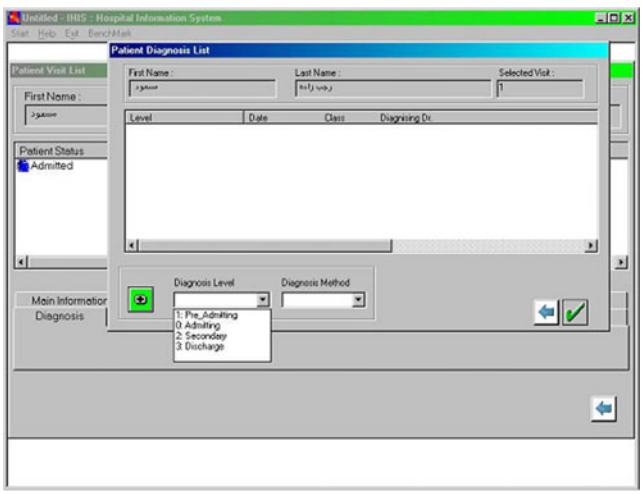

Fig. 3 Demo of the patient diagnosis list in patient visit list

The study which was done in American Hospital Association in 2005 indicated that only 10 % of HISs can actually use CDSS [23]; the results are in accordance with those of the present study. Wright et al. (2009) reported that the American HISs lacked the 43 % of capabilities for supporting the clinical decisions [24]. Felt-Lisk (2006) reported that 88 % of Colombian hospitals used the electronic laboratory results through CDSS. In half of the hospitals, the electronic laboratory orders were used and the electronic pictures saved using CDSS. Furthermore, the electronic prescriptions were used to suggest the appropriate treatment in 21 hospitals [25]; the results were not in accordance with those of the present study. Although there has been a significant increase in CDSS use, physicians and health care providers do not have enough knowledge about the capabilities of this system and the way of using that in raising productivity in Iran. Considering the importance of using CDSS, training the physicians how to use it in order to raise the quality of treatment and their fast access to the treatment methods are suggested.

Results of this study also showed that 1 hospital (3.3 %) had receiving information through Medline and 8 hospitals (26.7 %) the ability of providing access to the Internet and 6 hospitals (20 %) the ability of connecting to the digital library. Moreover, Chapula et al. (2005) reported that only 19.85 % of hospitals, related to the research population, had official website, 11.86 % had library and 3.39 % of them virtual library [26]. Yung and Ward (2001) reported that 57 % of general practitioners had computer in surgery room, 15 % access to the Internet and only 3 % of them access to the Cochrane library in their workplace [27]. These results are in accordance with those of the present study. Hersh and Hickam (1998) reported that physicians need more information for 2 out of 3 patients; they receive more than 68 % of this information through Medline and 19 % through electronic libraries [28]. Furthermore, Zare (2006) in his article "Approach to EBM among clinical faculty members" pointed out that 83.9 % of the study population had access to the Internet and electronic journals through local network of their university [29]; that is not in accordance with the results of the present study. It seems that the difference in the study population can cause the different results. To provide access to authentic papers and information bases for physicians, HIS should be connected to the library in hospitals and website of the universities. To achieve this purpose, information technology specialists, librarians and physicians should obviate the problems by forming a specialized team of experts collaborate and communicate with each other.

Research results also revealed that 8 hospitals (26.7 %) had access to disease specific bases and in 23 hospitals (76.7 %) retrieval of patients' problem lists with the same disease was possible. Mansson et al. study (2004) which

Table 2 Frequency distribution of the ability of HIS in providing access to clinical and administrative data repositories

Ability	Item	Had	Did not have
	1. registering clinical information by physicians	21(70)	9(30)
	2. registering diagnostic information	25(83.3)	5(16.7)
	3. registering patient's history	17(56.7)	13(43.3)
	4. registering the progress of the disease	16(53.3)	14(46.7)
	5. registering all of the physicians orders	25(83.3)	5(16.7)
	6. registering the primitive diagnosis	29(96.7)	1(3.3)
	7. registering the final diagnosis	29(96.7)	1(3.3)
	8. registering procedures and external causes	29(96.7)	1(3.3)
	9. registering qualitative laboratory test results	27(90)	3(10)
	10. registering quantitative laboratory test results	29(96.7)	1(3.3)
	11. registering qualitative drug information	23(76.7)	7(23.3)
	12. registering quantitative drug information	29(96.7)	1(3.3)
	13. registering qualitative radiology results	25(83.3)	5(16.7)
	14. registering quantitative radiology results	30(100)	0(0)
	15. registering information of drug sensitivities and the history of diseases	10(33.3)	20(66.7)
	16. registering other clinical information	10(33.3)	20(66.7)
	17. registering insurance information	30(100)	0(0)
	18. registering social worker information	22(13.3)	8(26.7)
	19. registering financial and reimbursement information	30(100)	0(0)
	20. registering statistical information of hospitalized indicators	25(83.3)	5(16.7)
	21. observing statistical information by physicians	21(70)	9(30)
	22. registering for consultation	22(73.3)	8(26.7)
	23. registering the results of consultation	15(50)	15(50)
	24. registering the coding of diseases	26(86.7)	4(13.3)
	25. registering the coding of external causes	26(86.7)	4(13.3)
	26. registering the coding for procedures	26(86.7)	4(13.3)
	27. Easy retrieval of clinical and administrative information for users	25(83.3)	5(16.7)

was carried out on 5 HISs for primary health care centers showed that all systems had the flexibility in information retrieval [30]; that is in accordance with the results of the present study. Langarizade (2003) reported that none of the study hospitals had access to the electronic documents of patients and even there was no possibility of observing the test results and paraclinical reports [31]. Moreover, Ahmadi et al. (2010) reported that only in 2 hospitals, HIS had the ability to retrieve information based on disease codes or a range of specific disease codes as well as do combined

Table 3 Frequency distribution of the ability of HIS in providing access to reference data base, internet-based health information and contextual and case-specific information

Ability	Item	Had	Did not have
Reference database	1. access to digital library	6(20)	24(80)
	2. receiving information from a reputable database	3(10)	27(90)
	3. connecting to the Portal of Medical Digital Resource (PMDR)	7(23.3)	23(76.7)
	4. connecting to the website of the university	8(26.7)	22(73.3)
	5. receiving information through Medline	1(3.3)	29(96.7)
	6. connecting to the reputable journals	0(0)	30(100)
Internet-based health information	1. access to the Internet	6(20)	24(80)
	2. access to the Internet websites that had health and medical information	6(20)	24(80)
Contextual and case-specific information	1. access to case-specific disease database	8(26.7)	22(73.3)
	2. retrieval of patients' list with similar disease	23(76.7)	7(23.3)

searching for the diseases. [20]; the results were not in accordance with those of the present study. It seems that the difference in the results of this study is due to the difference in the evaluated HISs as well as the time and place of the study. One of the methods for choosing an appropriate treatment is using the treatment methods that other physicians had already been used to treat diseases; this necessitates using the HISs. During planning, installing and implementing the software, physicians should have access to information in a way that they could retrieve the patients' information in any format to answer their clinical questions.

Furthermore, the ability of HISs in Iran *in clinical and administrative data repositories* was better than any other areas of research objectives. Overal, 25 out of 30 hospitals (83.3 %) had the ability to register statistical information and health indicators; 26 hospitals (86.7 %) the ability to register the coded data. The results of this study are not in accordance with those of Ahmadi et al. [20] and Hadianfard [32]. Differences in results can be attributed to time differences, type and analyzing methods of the studies. Despite the fact that HISs are gradually changing from financial information system to the clinical and administrative information system, the capability of clinical information is not actually being used. Moreover, it is recommended that physicians, like trained staff, should encourage using HISs.

Conclusion

Overall, HISs lack the ability to establish EBM in terms of providing access to CDSS and getting information through reference databases and Internet; it is more qualified to establish EBM in terms of clinical and administrative data repositories than other areas of research objectives. Although the most HISs have the ability of receiving, processing and retrieving the clinical and administrative information, it seems that using this information in HISs is faced with uncertainty and is used only as a simple computer system to insert information especially for financial and reimbursement uses.

Further suggestions

Physicians need quick and simple methods to answer their questions due to time shortage for studying; that can be reached by promoting HISs, a goal that needs managers and programmers of these systems have knowledge to revise HIS programs. As it is mentioned in this study, we can help the clinical staff through installing CDSS on the HISs to increase collaboration and consultation. Creating and saving reference databases for retrieval of authentic papers, creating disease databases and connecting it to specific-diseases databases, retrieving patient's information with similar diseases in this system, connecting HIS to the related website of university of medical sciences and also digital library stationed in the hospital or the university can assist physicians in getting answers to their medical questions. Moreover, promoting Windows-based systems and converting them into the Web-based systems can be beneficial. Furthermore, physicians should be trained to know how to use HIS, do more researches about designing a program in order to connect HIS to the digital library, have access to authentic papers through reference databases and use CDSS in HISs are recommended.

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References

1. Sackett, D. L., Rosenberg, W. M., Richardson, W. S., Hynes, R. B., and Muirgray, J. A., Evidence-based medicine: what it is and what it isn't. *BMJ* 312:71–72, 1996.
2. Rodrigues, J., Information systems: the key to evidence-based health practice. *Bull. World Health Organ.* 78(11):1344–1351, 2000.
3. Sackett, D. L., Straus, S. E., Richardson, W. S., Glasziou, P., Haynes, R. B. Evidence-Based Medicine: How to Practice and Teach EBM. BMJ; 2000.
4. Jeffrey, A., and Timothy, C., History and development of evidence- based medicine. *World J. Surg.* 29:547–553, 2005.
5. Soltani, A., *Evidence based medicine*, 2nd edition. Tehran University of medical science, Tehran, 2008 [In Persian].
6. Rube, T. Electronic health information: The key to evidence-based medicine and improved patient care. Gov. Insights 2008.
7. Soltani, A., Allameh, F., Hoseiny, M., and Forooqi, N., Evidence based medicine. *Ketabmah-Oloomfonoon J.* 1(3):63–65, 2007 [In Persian].
8. Zarin-ar, A., What is evidence based medicine. *Homa-ye-Salamat J.* 20:71–74, 2008.
9. Hunt, D. L., Haynes, R. B., and Hanna, S. E., Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. *JAMA* 280:1339–1346, 1998.
10. Firooz, A. R., and Khatami, A. R., A review on evidence-based medicine. *Iran. J. Dermatol.* 7(26):101–111, 2004 [In Persian].
11. Bukken, S., An informatics infrastructure is essential for evidence-based practice. *J. Am. Med. Inform. Assoc.* 8:199–201, 2001.
12. Sackett, D. L., and Rosenberg, W. M., The need for evidence-based medicine. *J. R. Soc. Med.* 88:620–624, 1995.
13. Mckibbon, K. A., Evidence-based practice. *Bull. Med. Libr. Assoc.* 86:369–401, 1998.
14. Wells, L., Role of information technology in evidence based medicine: advantages and limitations. *Internet J. Healthc. Admin* 4(2), 2007.
15. Aminpour, F., Medical informatics: concepts and applications. *Iran. J. Med. Educ.* 4(2):95–103, 2004 [In Persian].

16. Mueller, M. L., Ganslandt, T., Frankewitsch, T., Krieglstein, C. F., Senninger, N., Prokosch, H. U. Workflow analysis and evidence-based medicine: Towards integration of knowledge-based functions in hospital information systems. Proc AMIA Symp. 330–334, 1999. PMC2232821.
17. Hemiear, M., Improving patient safety with technology. *Int. J. Med. Inform.* 73(7–8):543–546, 2004.
18. Humphreys, L., Electronic health record meets digital library: a new environment for achieving an old goal. *J. Am. Med. Inform. Assoc.* 7(5):444–452, 2000.
19. Humphreys, B. L., and Lindberg, D., The UMLS project: making the conceptual connection between users and the information they need. *Bull. Med. Libr. Assoc.* 81(2):170–177, 1993.
20. Ahmadi, M., Barabadi, M., and Kamkar Haghighy, M., Evaluation of hospital information system in the medical records department. *Health Inf. Manag.* 7(1):16–23, 2010.
21. Information Technology Department of Kashan Universitiy of Medical Sciences. List of Companies producing HIS Soft ware, Kashan: Iran,2011
22. Iran Trade Organization's computer. List of active non government computer's companies in E.Health & Medical IT. Available on: http://www.irannsr.org/index.php. a
23. Clamp, S., and Keen, J., Electronic health record: is the evidence base any use? *Med.Inform. Internet Med.* 32(1):5–10, 2007.
24. Wright, A., Sittig, D. F., Ash, J. S., Sharma, S., Pang, J. E., and Middleton, B., Clinical decision support capabilities of commercially-available clinical information systems. *J. Am. Med. Inform. Assoc.* 16(5):637–644, 2009.
25. Falt-Lisk, S. New hospital information technology: is it helping to improve quality. MATEMATICA policy research, Inc 2006; 3:1–4. available at from: http://www.matematicampr.com/health/qualityofcare.asp
26. Macias-chapula, C. A., Rodea-Castro, I. P., Mendoza-Guerreo, J. A., Gutierrez-Carrasco, A. Hospital virtual libraries in latin America and the Caribbean: A web metric analysis. Research unit, hospital general de Mexico 2005.
27. Young, J. M., and Ward, J. E., Evidence-based medicine in general practice: beliefs and barriers among Australian GPs. *J. Eval. Clin. Pract.* 7(2):201–210, 2001.
28. Hersh, R., and Hickam, H., How well do physicians use electronic information retrieval systems? A framework for investigation and systematic review. *JAMA* 280(15):1347–1352, 1998.
29. Zare, V., Evidence based medicine approach among clinical faculty members. *Med. J. Tabriz Univ. Med. Sci. Health Serv.* 28(1):61–66, 2006 [In Persian].
30. Mansson, J., Nilsson, G., Bjorkelund, C., and Strender, L.-E., Collection and retrieval of structured clinical data from electronic patient records in general practice. *Scand. J. Prim. Care* 22:6–10, 2004.
31. Langarizade ,M. A study of software utilization in medical records departments in teaching hospitals of medical science based in Tehran. [Thesis]. Tehran: Iran University of medical science; 2003. [in Persian]
32. Hadianfard, A. The survey of hospital information system structure in Shiraz hospitals. [Thesis]. Tehran: shahid Beheshti University of medical science; 2002. [in Persian]