Determining the most important evaluation indicators of healthcare information systems (HCIS) in Iran

Leila Shahmoradi, Maryam Ahmadi and Hamid Haghani

Abstract

Accurate evaluation of healthcare information systems (HCIS) relies upon the choice of appropriate indicators. Iranian healthcare and health industry professionals were surveyed, by means of a descriptive cross sectional study, in order to identify the indicators they considered most relevant to the evaluation of healthcare information systems currently in use in Iran. It was concluded that effective evaluation of HCIS should encompass a variety of perspectives and methodologies (including qualitative methodologies), focus upon technical, economic and organisational concerns, and involve diversely constituted research teams.

Key words (MeSH):

Evaluation; Evaluation Methodology; Qualitative Research; Hospital Information Systems; Health Care Systems; Iran

Introduction

The use of healthcare information systems (HCIS) is commonplace in many healthcare institutions. These systems have been shown to provide benefits such as improved nursing efficiency, greater patient safety and satisfaction (Bowles 1997), and improved documentation (Nahm & Poston 2000). Because HCIS have a high cost and their implementation can be very disruptive for organisations and their staff, it is important that these systems should be critically evaluated (Wyatt & Wyatt 2003). Evaluation is not necessarily an aspect that is separate from HCIS, but can be an integral part of the process (Birkmeyer, Bates & Birkmeyer 2002).

Friedman and Wyatt (cited in Wyatt & Wyatt 2003) state that HCIS are designed to improve healthcare quality by facilitating information management and health centre management. These objectives have been achieved, according to Bates et al. (cited in Neville et al. 2004). HCIS have been developed in order to integrate health information systems to meet consumer needs, contribute to epidemiological research, enhance care quality, reduce expenses (Farshid 2002) and facilitate information management (Mitchell & Sullivan 2001). There are several ways in which to establish and develop an information system which incorporates definition of objectives, performance and applicability factors, design characteristics, and evaluation (Abdelhak 2001). Evaluation is the aspect of concern in this article.

A review of evaluation methodologies

Traditionally, evaluation of the components of medical or health information systems has focused on technical and systems features that affect systems use, cost-benefit analysis, user acceptance and patient outcomes (Neville et al. 2004).

Using the Medline and EMBASE (1995-2004) databases, a review of the literature on evaluation methodology was conducted. The main points of interest were evaluation steps, evaluation types, HCIS studies in general, study tools and evaluation indicators.

Evaluation perspectives

Evaluation can be approached from various perspectives: for example objectivist versus subjectivist (Friedman & Wyatt, cited in Neville et al. 2004); formative versus summative (King, Morris & Fitz-Gibbon 1987; Rossi & Freeman 1993); scientific versus pragmatic evaluation perspectives (Rossi & Freeman 1993; Cook &

Campbell 1979); and accountability, developmental and knowledge perspectives (Heathfield, Pitty & Hanka 1998).

Approaches to evaluation

There are six steps to HCIS evaluation:

- Step 1: establish why an evaluation is needed
- Step 2: determine when to evaluate
- Step 3: determine what to evaluate
- Step 4: decide how to evaluate
- Step 5: analyse and report
- Step 6: assess recommendations and decide on actions (United Kingdom Institute of Health Informatics for ERDIP 2001).

In addition there are thirteen study methods for HCIS evaluation, all of which have inherent advantages and disadvantages:

- usability testing
- non-comparative study
- comparative study
- before and after study
- usability engineering
- randomized controlled trial
- cognitive psychology
- cost-benefit analysis
- cost-effectiveness analysis
- repeated measures study
- reimplementation review
- implementation review
- operational review (Neville et al. 2004).

Evaluation criteria

Many criteria are used in hospital computerised systems evaluation. Based on interviews with hospital personnel carried out by Geisler and Heller, the following criteria were selected for this study: economic compensation, utility enhancement, patient satisfaction, cost reduction, compliance with accreditation requirements, improvement of performance, achievement of organisational mission, improvement of delivered service, maximum utility of human resources, improvement in departmental efficiency, data accuracy improvement and financial payer's satisfaction (Geisler & Heller 1998). The important questions to be asked are:

- Is this evaluation beneficial to the improvement of the health system within the organisation or not? (Wyatt & Wyatt 2003).
- What is objective of this evaluation? (Carter, cited in Neville et al. 2004).

Evaluation methods

There are many possible methods of evaluation (Seddon 2001). Most literature reviews have a formal-rational view (Walsham 1993, cited in Cronholm & Goldkuhl 2003), and from this perspective evaluation is regarded as a vast qualitative cost-benefit analysis. The objective of evaluation methods such as formal-rational, interpretative and criteria-based, is to indicate the quality of evaluation (Cronholm & Goldkuhl 2003).

In Iran, Ave Rasoul and Khani classified performance evaluation indicators in Information Technology (IT) projects in four groups:

- learning and development indicators
- process indicators
- customer satisfaction indicators
- financial indicators (Ave Rasoul & Khani, 2004).

King, Morris and Festingbon (cited in Neville et al. 2004) have mentioned two types of evaluation for HCIS projects. The following factors influence evaluation of a health information system:

- use of the HCIS by a variety of specialists
- use of the HCIS for re-engineering
- change in evaluation results with new recruits
- multi-functional health information system (admission, discharge, transmission etc.)
- use of the same HCIS by different organisations (Friedman & Wyatt 2003, cited in Neville et al. 2004; Gadd & Penrod 2001; Littlejohns, Wyatt & Gavican 2003; Heathfield & Pitty, cited in Neville et al. 2004).

Evaluation indicators and questions should be designed and considered according to the above-mentioned issues. If questions and indicators are designed and selected realistically, they can solve many of these problems (Keshavjee et al. 2001; Heathfield, Pitty & Hanka 1998; Heathfield et al. 1999, cited in Neville et al 2004). Unfortunately, indicators, data sources and evaluation methods were not defined clearly in this article. The same evaluation indicators should not be used in all countries because there are differences in system characteristics.

Method

This descriptive, cross-sectional study of evaluation criteria was conducted in 2004. Its design was developed using the principles and methods described in the above review. A questionnaire containing 20 questions for each objective was devised based on indicators suggested in Neville et al. (2004). For the purpose of this paper, an evaluation tool was developed using a four-point Likert scale to determine the most important HCIS evaluation indicators.

Each question offered a selection of several indicators, and a free choice was also included in each question in order to give respondents the opportunity to identify other indicators that were not mentioned in the questionnaire. The participating experts were doctoral students in health information management at the Iran Medical Science University (which is the only Iranian university offering doctorates in this field), four well-known companies which deal in information systems, and teaching staff at the Medical Sciences Departments in the University of Tehran, Shahid Beheshti University and the Iran University of Science and Technology (three universities in Tehran that have expertise this field). The sampling method was simple; study participants were industry and health professionals easily accessible to the researchers via their own institutions. The respondents' demographic characteristics are shown in Table 1.

Sixty-four percent of respondents either held PhDs or were PhD students, 28% held the Master of Science degree and 7% were Bachelors of Science. Most of the experts (53%) were male, 32% were female while 14% did not specify their gender. Thirty-two percent of the experts were Health Information Managers, and many (57%) of the experts were members of scientific boards. The majority of experts resided in Tehran (74%) and Tabriz (11%) and they had worked in the field for 10-15 years. As explained above, the location of the respondents was concentrated in these cities because of the ease of access by the researchers, who also worked in these locations.

Table 1: Demographic characteristics

	NUMBER (n=28)	PERCENT (APPROX)
ACADEMIC QUALIFICATION		
Ph.D.	18	64%
Master of science	8	28%
Bachelor of science	2	7%
Diploma	–	–
GENDER		
Male	15	53%
Female	9	32%
Not specified	4	14%
EDUCATION FIELD		
Health information management	9	32%
Medical engineer	4	14%
Medical records	4	14%
Others (eg. health services management)	9	32%
Not specified	2	7%
POSITION		
Membership of scientific board	16	57%
Medical specialist	10	35%
Other	2	7%
AGE		
20-25 years	2	7%
25-30 years	4	24%
30-35 years	9	32%
35-40 years	3	10%
40-45 years	3	10%
>45 years	7	25%
CITY OF RESIDENCE		
Tehran	20	74%
Tabriz	3	11%
Mashad	2	7%
Shahrood	2	7%
Kashan	1	4%
YEARS OF WORK		
01-May	3	11%
05-Oct	8	26%
Oct-15	10	29%
>15	3	11%
Not specified	4	14%

The questionnaire was distributed to 35 experts, 28 of whom completed the questionnaire, constituting a response rate of 80%. Teaching staff studied the validity and reliability of the questionnaire before the experts' viewpoints were gathered. After 15 days, the questionnaire was re-sent to the experts to confirm its reliability. According to a binominal test, 75% of the indicators were considered as the most important indicators; these are shown in Appendix A.

Table 2 shows those indicators considered by the respondents to be the most important. In this table data is divided into two classification: Group 1 contains indicators of 'little' importance and of 'less' importance, and Group 2 contains those indicators of 'high' importance and 'very high' importance. According to the binominal test, 75% of indicators selected by the experts as 'important' and 'most important' were considered as the most important indicators. Collected questionnaires were analysed using SPSS software.

Results

Evaluation indicators

In a study by Neville and colleagues, 63 indicators for the evaluation of electronic health record initiatives were listed (Neville et al. 2004). Thirty-one indicators from these 63 were selected by the responding experts in this study as being the most important.

Additional indicators deemed important by the respondents included projections of system costs and benefits, and return on investment (ROI). The results suggest that these factors are not important in Iranian government systems, and that they can also be considered in non-governmental organisations. They also suggested that an indicator of 'system effects' is important in Iran government systems.

Table 2: Indicators

	FREQUENCY	PERCENT
DATA AVAILABILITY		
Group 1 ('little' or 'less' importance)	3	11%
Group 2 ('high' or 'very high' importance)	24	89%
Total	27	100%
DATA COMPLETENESS		
Group 1 ('little' or 'less' importance)	5	19%
Group 2 ('high' or 'very high' importance)	22	81%
Total	27	100%
SYSTEM RESPONSE TIMES		
Group 1 ('little' or 'less' importance)	3	11%
Group 2 ('high' or 'very high' importance)	24	89%
Total	27	100%
TIME TO COMPLETE TASKS		
Group 1 ('little' or 'less' importance)	4	15%
Group 2 ('high' or 'very high' importance)	23	85%
Total	27	100%
SERVICE QUALITY		
Group 1 ('little' or 'less' importance)	2	7%
Group 2 ('high' or 'very high' importance)	25	93%
Total	27	100%
USER SATISFACTION		
Group 1 ('little' or 'less' importance)	9	33%
Group 2 ('high' or 'very high' importance)	18	67%
Total	27	100%
COST OF TRAINING/USER SUPPORT		
Group 1 ('little' or 'less' importance)	7	25%
Group 2 ('high' or 'very high' importance)	21	75%
Total	28	100%
AVOIDANCE OF ERRORS		
Group 1 ('little' or 'less' importance)	6	21%
Group 2 ('high' or 'very high' importance)	22	79%
Total	28	100%
AVOIDANCE OF ADVERSE EVENTS		
Group 1 ('little' or 'less' importance)	7	25%
Group 2 ('high' or 'very high' importance)	21	75%
Total	28	100%
IMPROVED COMMUNICATIONS		
Group 1 ('little' or 'less' importance)	6	–
Group 2 ('high' or 'very high' importance)	21	78%
Total	27	100%
SYSTEM QUALITY		
Group 1 ('little' or 'less' importance)	5	19%
Group 2 ('high' or 'very high' importance)	22	81%
Total	27	100%
ENHANCED CAPACITY TO ACHIEVE STRATEGIC GOALS		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%

	FREQUENCY	PERCENT
OPERATING COSTS		
Group 1 ('little' or 'less' importance)	7	26%
Group 2 ('high' or 'very high' importance)	20	74%
Total	27	100%
WAITING TIMES		
Group 1 ('little' or 'less' importance)	4	15%
Group 2 ('high' or 'very high' importance)	23	85%
Total	27	100%
DISCHARGE PLANNING		
Group 1 ('little' or 'less' importance)	6	22%
Group 2 ('high' or 'very high' importance)	21	78%
Total	27	100%
ACCESS TO CLINICAL INFORMATION WHEN NEEDED		
Group 1 ('little' or 'less' importance)	5	19%
Group 2 ('high' or 'very high' importance)	22	81%
Total	27	100%
WORKFLOW PROCESSES		
Group 1 ('little' or 'less' importance)	4	15%
Group 2 ('high' or 'very high' importance)	23	85%
Total	27	100%
WORKFORCE SATISFACTION		
Group 1 ('little' or 'less' importance)	6	22%
Group 2 ('high' or 'very high' importance)	21	78%
Total	27	100%
PROJECT MANAGEMENT DOCUMENTS		
Group 1 ('little' or 'less' importance)	6	21%
Group 2 ('high' or 'very high' importance)	22	79%
Total	28	100%
USE OF UNNECESSARY TESTS		
Group 1 ('little' or 'less' importance)	7	26%
Group 2 ('high' or 'very high' importance)	20	74%
Total	27	100%
ANALYSIS OF DECISION-MAKING		
Group 1 ('little' or 'less' importance)	5	19%
Group 2 ('high' or 'very high' importance)	22	81%
Total	27	100%
USER SATISFACTION WITH USER INTERFACE AND SYSTEM FUNCTIONALITY		
Group 1 ('little' or 'less' importance)	7	26%
Group 2 ('high' or 'very high' importance)	20	74%
Total	27	100%
IMPLEMENTATION TIMELINES		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
USE OF THE SYSTEM TO MAKE DECISIONS		
Group 1 ('little' or 'less' importance)	6	22%
Group 2 ('high' or 'very high' importance)	21	78%
Total	27	100%

	FREQUENCY	PERCENT
PRIVACY PROTOCOLS		
Group 1 ('little' or 'less' importance)	6	21%
Group 2 ('high' or 'very high' importance)	22	79%
Total	28	100%
COSTS OF PROJECTIONS OF SYSTEM		
Group 1 ('little' or 'less' importance)	5	18%
Group 2 ('high' or 'very high' importance)	23	82%
Total	28	100%
COST OF TRAINING/USER SUPPORT		
Group 1 ('little' or 'less' importance)	4	15%
Group 2 ('high' or 'very high' importance)	23	85%
Total	27	100%
PROJECT MANAGEMENT STRUCTURES IN PLACE		
Group 1 ('little' or 'less' importance)	5	19%
Group 2 ('high' or 'very high' importance)	22	81%
Total	27	100%
SECURITY/PRIVACY STRUCTURES IN PLACE		
Group 1 ('little' or 'less' importance)	5	19%
Group 2 ('high' or 'very high' importance)	22	81%
Total	27	100%
PATIENT SCHEDULING		
Group 1 ('little' or 'less' importance)	6	22%
Group 2 ('high' or 'very high' importance)	21	78%
Total	27	100%
TURN AROUND TIME FOR LAB AND DIAGNOSTIC TESTS		
Group 1 ('little' or 'less' importance)	7	25%
Group 2 ('high' or 'very high' importance)	21	75%
Total	28	100%
WORKFLOW ANALYSIS		
Group 1 ('little' or 'less' importance)	6	22%
Group 2 ('high' or 'very high' importance)	21	78%
Total	27	100%
USE OF ON-LINE HELP FUNCTIONS		
Group 1 ('little' or 'less' importance)	9	33%
Group 2 ('high' or 'very high' importance)	18	67%
Total	27	100%
COSTS IN IMPLEMENTATION PROCEEDING		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
VALIDITY AND RELIABILITY ESTIMATES OF COST AND BENEFIT INDICATORS		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
COMMUNICATION PATTERNS		
Group 1 ('little' or 'less' importance)	7	26%
Group 2 ('high' or 'very high' importance)	20	74%
Total	27	100%

Table 2: Indicators *continued*

	FREQUENCY	PERCENT
MEDICATION PRESCRIBING		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
USE OF THE SYSTEM TO MAKE DECISIONS		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
CHANGE REQUESTS		
Group 1 ('little' or 'less' importance)	10	37%
Group 2 ('high' or 'very high' importance)	17	63%
Total	27	100%
WORKFORCE LOYALTY		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
TOTAL USER PERFORMANCE IN SIMULATIONS		
Group 1 ('little' or 'less' importance)	8	30%
Group 2 ('high' or 'very high' importance)	19	70%
Total	27	100%
TASK ANALYSIS		
Group 1 ('little' or 'less' importance)	9	33%
Group 2 ('high' or 'very high' importance)	18	67%
Total	27	100%
RECOGNITION OF IS ROLE IN OTHER POLICY INITIATIVES, i.e. primary care, regionalisation, wellness, move to evidence-based decision-making		
Group 1 ('little' or 'less' importance)	8	29%
Group 2 ('high' or 'very high' importance)	20	71%
Total	28	100%
USER FEEDBACK		
Group 1	10	37%
Group 2	17	63%
Total	27	100%
BENEFITS IN PROJECTIONS OF SYSTEM		
Group 1	7	50%
Group 2	21	50%
Total	28	100%
RETURN ON INVESTMENT (ROI)		
Group 1	14	50%
Group 2	14	50%
Total	28	100%
SUPPORT GIVEN IN THE PAST TO EHR TYPE SYSTEMS DEVELOPMENT (EG FINANCIAL, POLITICAL)		
Group 1	18	64%
Group 2	10	36%
Total	28	100%

Discussion

DeLone and McLean (2003) listed six main indices to be used in an evaluation study:

- system quality
- information quality
- information use
- user satisfaction
- individual effect
- organisational effect.

Although indicators identified by Neville et al. (2004) encompass those of DeLone and McLean (2003), their definition of the indicators by the former was not considered clear or sufficient for the present study. DeLone and McLean give clear definitions of each indicator in their model of information systems, and it was therefore decided to use these indicators in evaluations of HCIS.

In Kaplan's evaluation model the relationships between a system's characteristics, individual characteristics, organisational characteristics and their effects were considered. Kaplan suggested that an evaluation framework should focus on a variety of technical, economic and organisational concerns, and should use multiple methods, be modifiable, be longitudinal, and be part of both of the formative and summative evaluation (Kaplan 1998). Most experts taking part in the present study agreed that in a comprehensive evaluation framework all of these aspects should be considered. Similarly, the evaluation framework devised by Neville et al. (2004) covered these aspects, while many studies also focused on comprehensive evaluation studies in order to encompass the entire spectrum of the complexity and dynamics of healthcare information systems (Friedman & Wyatt, cited in Neville 2004; Burkle et al. 2001; Moehr 2002; Stoop & Berg 2003).

Kushniruk proposed usability testing, cognitive analysis and computerised videotape analysis to measure user satisfaction (Kushniruk 2002). In the evaluation framework suggested by Neville et al. (2004), user satisfaction indicators were denoted. It should be recognised, however, that cognitive methods such as questionnaires and interviews rely on the user's memory and experience of existing computerised systems which do not necessarily reflect their 'actual' behaviour. Consequently an evaluation process should be coordinated with the existing medical system. Kushniruk and colleagues noted that cognitive

evaluation can be applied to the whole information system cycle from informative evaluation to summative evaluation (Kushniruk, Patel & Ciminio 1997). Finally, they suggested that process variables such as usability engineering should be integrated with output variables in future HCIS evaluations.

The Neville et al. evaluation framework shows indicators of projections of system costs and benefits and return on investment (ROI). The experts in the present study observed that although these indicators may not be important in Iranian government systems, they could be considered in nongovernmental organisations. They also suggest that a system effects indicator is important in present-day Iranian government systems.

Other indicators for management structures as well as indicators of project management documents, standards and privacy protocols are identified by the experts:

- determining existing work process
- SWOT analysis (Strength, Weakness, Opportunity, Threats)
- determining existing work communication
- developing special department for information system
- determining strategy
- determine specialist in information system department
- clear documentation of work process

For administrative benefits in comparison with projected benefits, Neville et al. recommended indicators of improved communications and enhanced capacity to achieve strategic goals. In order to determine the level of data quality, they added indicators such as minimising the volume of data, data sharing, and relatedness of data, in answer to the question: 'What are the current levels of data quality?' together with indicators identified by Neville et al. (2004) (data availability, data completeness and data accurateness). They stated that it is important to consider answering the question 'How do linkages through IT affect organisational identity and integrity?', but they observed that it is difficult measure IT affects on organisational identity and integrity with indicators of workflow processes, communication patterns, workforce satisfaction, workforce loyalty and strategic use of IT in decision making.

Iranian information system designers, however, do not regard these indicators as being significant and, as a consequence, the application of these factors in their programs is low. It is noted that Gremy, Fessler and Bonnin claim that because information systems coexist with their human users, the presence of subjectivity is an objective fact that cannot be deleted from HCIS evaluations (Gremy, Fessler & Bonnin 1999). In addition, Protti (2002) stated that it is important to develop a process for engaging stakeholders, particularly physicians, in establishing principles and premises for large information systems projects.

DeLone and McLean (1992; 2003) suggested the following indicators of information quality, for determining the success of information system implementation: system quality, service quality, use or intention to use, user satisfaction and net benefits. The Iranian experts in the present study, however, added 'indicators of the system dynamics for answering future needs' to these factors.

Heathfield, Pitty and Hanka (1998) note that current health information system evaluations have tended to focus on the accountability perspective, with a subsequent preoccupation with randomised control trials (RCT) and quantitative approaches (Heathfield at al. 1997). They emphasise that new multi-method approaches are required. While sensitivity to accountability is heightened in times of resource constraint, they argue that evaluation focused on accountability in order to regain public trust is shortsighted and limits the gains that can be achieved from the developmental and knowledge perspectives on evaluation in the health information system field.

Systems should also be evaluated for their ability to meet the legal requirements of healthcare professionals (Manning & McConnell 1997). Determining the criteria to be used in a healthcare information systems evaluation depends on many factors, including what type of system is being evaluated, who the stakeholders are, what methodology is being used and what financial or time constraints need to be considered.

Conclusion

In order to achieve an accurate and reproducible evaluation of any system there should be a clear definition of each evaluation and measurement indicator. Indeed, comprehensive evaluation of healthcare information systems requires the use of several indicators. A qualitative approach to the analysis is useful for assessment of opportunities for improvement of health information systems. Since various evaluators arrive at different results from their measurement, probable independent variables such as subjective opinion, size, structure, strategy, organisational environment and system characteristics should be taken into account. The purpose of evaluation is not just to assess accountability; it also informs system development and knowledge building.. We recommend that uture evaluations encompass a number of perspectives and methodologies, including qualitative methods, and that they involve diversely constituted research teams.

In summary, evaluation frameworks should:

- focus on a variety of technical, economic and organisational concerns
- use multiple methods
- be modifiable
- be longitudinal
- be formative and summative.

We conclude that multiple approaches to HCIS evaluation should be employed in order to encompass the entire spectrum of the complexity and dynamics of healthcare information systems and the organizations in which they reside.

References

Abdelhak, M., Grostick, S., Hanken, A. and Jacobs, E. (2007). *Health information: management of a strategic resource.* Philadelphia, W.B. Saunders.

Ave Rasoul, A. and Khani Jagharg, N. (2004). Performance evaluation in information technology projects. *Tadbir Manajing Magazine* 149: 33-37.

Birkmeyer, C.M., Bates, D.W. and Birkmeyer, J.D. (2002). Will electronic order entry reduce health care costs? *Effective Clinical Practice* 5(2), 67-74.

Bowles, K. (1997). The barriers and benefits of nursing information systems. *Computers in Nursing* 15(4): 191-196.

Burkle, T., Ammenwerth, E., Prokosch, H., and Dudeck, J. (2001). Evaluation of clinical information systems. What can be evaluated and what cannot? *Journal of Evaluation in Clinical Practice* 7(4): 373-85.

Cook, T.D. and Campbell, D.T. (1979). *Quasi-experimentation: design and analysis issues for field settings.* Boston, Houghton Mifflin.

Cronholm, S. and Goldkuhl, G. (2003). Six generic types of information systems evaluation. *The 10 th European Conference on Information Technology Evaluation (ECIT-2003)*. Madrid.

DeLone, W.H. and McLean, E.R. (2003). The DeLone and McLean model of information system success: a ten year update. *Journal of Management Information Systems* 19(4): 9-30.

Farshid, P. (2002). *Survey of the attitudes of medical records personal on hospital information system development at 2001-2002*. MSc (Medical Records) thesis, Department of Health Information Management, Iran University of Medical Sciences.

Gadd, C.S. and Penrod, L.E. (2001). Assessing physician attitudes regarding use of an outpatient EMR: a longitudinal, multi-practice study. *Proceedings of the AMIA Symposium 2001*:194-198.

Geisler, E. and Heller, O. (1998). *Management of medical technology: theory practice and cases.* Boston, Kluwer Academic Publisher.

Gremy, F., Fessler, J. M. and Bonnin, M. (1999). Information systems evaluation and subjectivity. *International Journal of Medical Informatics 56*: 13-23.

Heathfield, H., Pitty, D. and Hanka, R. (1998). Evaluating information technology in health care: barriers and challenges. *British Medical Journal* 316 (7149): 1959-1961.

Heathfield, H.A., Peel, V., Hudson, K.S., Mackay, L. and Marley, T. (1997). Evaluating large scale health information systems: from practice towards theory. *Proceedings of the AMIA Annual Symposium*: 116-120.

Kaplan, B. (1998). Social Interactionist framework for information systems studies: the 4 Cs. *Proceedings of the IFIP WG8.2 & 8.6 Joint Working Conference on Information Systems: current issues and future changes*: 327-339.

Keshavjee, K., Troyen, S., Holbrook, A.M. and VanderMolen, D. (2001). Measuring the success of electronic medical record implementation using electronic and survey data. Proceedings of the AMIA Symposium: 309-312. Available at: http://www.amia.org/pubs/proceedings/symposia/2001/D010001610.pdf (accessed 14 December 2004).

King, J.A., Morris, L.L. and Fitz-Gibbon, C.T. (1987). *How to assess program implementation.* Thousand Oaks, California, Sage Publications.

Kushniruk, A. (2002). Evaluation in the design of health information systems: application of approaches emerging from usability engineering. *Computers in Biology and Medicine* 32(3): 141-149.

Kushniruk, A.W., Patel, V.L. and Ciminio, J.J. (1997). Usability testing in medical informatics: cognitive approaches to evaluation of information systems and user interfaces. *Proceedings of the AMIA Annual Symposium*: 218-222. Available at: http://www.dbmi.columbia.edu/cimino/Publications/ 997%20%20SCAMC%20%20Usability%20Testing%20in%20Medical%20Informatics%20%20Cognitive%20Approaches%20to%20Evaluation%20of%20Information%20Systems%20and%20User%20Interfaces.pdf (accessed 29 December 2004).

Littlejohns, P., Wyatt, C. J. and Gavican, L. (2003). Evaluating computerized health information systems: hard lesson still to be learnt. *British Medical Journal* 326: 860-863.

Manning, J. and McConnell, E. (1997). Technology assessment: a framework for generating questions useful in evaluating nursing information systems. *Computers in Nursing* 15(3): 141-146.

Mitchell, E. and Sullivan, F. (2001). A descriptive feast but evaluative famine: systematic review of published articles on primary care computing during 1997-1980. *British Medical Journal* 322: 279-282. Available at: http://pubmed-central.nih.gov/articlerender.fcgi?artid=26582&rendertype (accessed 27 July 2004).

Moehr, J.R. (2002). Evaluation: salvation or nemesis of medical informatics? *Computers in Biology and Medicine* 32: 113-125.

Nahm, R. and Poston, I. (2000). Measurement of the effects of an integrated, point-of-care computer system on quality of nursing documentation and patient satisfaction. *Computers in Nursing, 18*(5), 220-229.

Neville, D., Gates, K., MacDonald, D., Barron, M., Tucker, S. Cotton, S. and Gerard Farrell, G., Hoekman, T., Bornstein, S. and O'Reilly, S. (2004). *Toward an evaluation framework for electronic health records initiatives: A proposal for an evaluation framework*. Available at: http://www.nlchi.nl.ca/pdf/final_framework.pdf. (accessed 6 March 2004).

Protti, D. (2002). The power of principles and premises: using them to help define the EHR. *Healthcare Management Forum* 15(3): 46-48.

Rossi, P.H. and Freeman, H.E. (1993). Evaluation: a systematic approach (fifth edition). Newbury Park, California, Sage Publications.

Seddon, P. (2001). *IT evaluation revisited: plus ca changes* (Abstract). Proceedings of Eighth European Conference on Information Technology (ECITE). Oxford, United Kingdom.

Stoop, A.P. and Berg, M. (2003). Integrating quantitative and qualitative methods in patient care information system evaluation: guidance for the organisational decision maker. *Methods of Information in Medicine* 42(4): 458-462.

United Kingdom Institute of Health Informatics for ERDIP (2001) March. Project Review and Objective Evaluation (PROBE) for electronic patient and health record projects. Available at: www.nlchi.nf.ca/pdf/final_evaluation_report.pdf (accessed 27 October 2004).

Wyatt J.C. and Wyatt, S.M. (2003). When and how to evaluate health information systems? *International Journal of Medical Informatics* 69(2-3): 251-259.

Corresponding author:
Leila Shahmoradi *MSc*
School of Management and Medical Information Sciences
Iran University of Medical Sciences
Babak Bahrami St.,
across Niayesh Highway-Valey-e-asr St.-
Tehran
IRAN
email: L2000shahmoradi@yahoo.com

Maryam Ahmadi *PhD*
Assistant Professor
School of Management and Medical Information Sciences
Iran University of Medical Sciences
Babak Bahrami St.,
across Niayesh Highway-Valey-e-asr St.-
Tehran
IRAN
email: hehsidna@iums.ac.ir

Hamid Haghani *PhD*
Assistant Professor
School of Management and Medical Information Sciences
Iran University of Medical Sciences
Babak Bahrami St.,
across Niayesh Highway-Valey-e-asr St.-
Tehran
IRAN
email: haghani511@yahoo.com

Appendix A

Evaluation question and indicators administered in three timeframes (Pre-Implementation, Implementation and Post Implementation)

1. What are the predicted benefits and costs of this system?
   - Projections of system: Costs, Benefits, Return on investment (ROI)
2. Does this investment fit strategically with the direction and priorities in the jurisdiction?
   - Support given to EHR type systems development in the past, financial/political
   - Recognition of the role of IS in other policy initiatives, i.e. primary care, regionalization, wellness, move to evidenced-based decision-making
3. Are the necessary management structures in place?
   - Project management documents
   - Standards
   - Privacy protocols
4. What were the costs of implementing this system and how do they compare with projected costs?
   - Cost of the technology
   - Personnel costs
   - Cost of training/user support
5. What benefits were achieved and how do they compare with projected benefits?
   - Clinical benefits
   - Avoidance of errors
   - Avoidance of adverse events
   - Improved patient outcomes
   - Improved information quality
6. What Administrative benefits were achieved and how do they compare with projected benefits?
   - Improved communications
   - Enhanced capacity to achieve strategic goals
7. What economic/ resource benefits were achieved and how do they compare with projected benefits?
   - Operating costs
   - Length of stay
   - Use of unnecessary tests
   - Visits per clinician
   - Waiting times
8. What is the state of readiness within the sites for implementation of the system?
   - Training and support programs in place
   - Project management structures in place
   - Security/privacy structures in place

9 What are the expectations and concerns of key stakeholders?
   - Stated expectations for the system's impact upon: patient safety, clinical productivity, relationship with patients, costs, privacy and communication

10. What are the current levels of data quality?
    - Data availability
    - Data completeness
    - Data accurateness
11. Is the new system technically able to perform the functions expected of it?
    - Data availability
    - Data completeness
    - Data accurateness
12. What are the current work processes in the areas which will be impacted by the new system?
    - Patient scheduling
    - Discharge planning
    - Medication prescribing
    - Turn around time for laboratory and diagnostic tests
    - Access to clinical information when needed
    - Workflow analysis
    - Analysis of decision-making
13. Is this system useable?
    - System response times
    - User satisfaction with user interface and system functionality
    - Time for task completion
    - Ease of access
14. Does the system deliver the information clinicians and managers need in order to make decisions?
    - Time to complete tasks
    - Use of the system to make decisions
    - Routine use of the system
15. Is the necessary level of support available to individuals to allow them to use the system efficiently and effectively?
    - Routine use of the system
    - Use of on-line help functions
    - Use of technical support personnel
    - Time to complete tasks
16. Is the implementation proceeding as anticipated?
    - Implementation timelines
    - Change requests
    - Costs
17. Can the costs and benefits of these EHR systems be quantified?
    - Validity and reliability estimates of cost and benefit indicators
18. How may information technologies be tailored for use by a wide variety of individuals in a wide variety of places?
    - User performance in simulations
    - User feedback
    - Task analysis
19. What is a successful implementation of an information system and what is the best way to measure it?
    - Information quality
    - System quality
    - Service quality
    - Use or intention to use
    - User satisfaction
    - Net benefits
20. How do linkages through IT affect organisational identity and integrity?
    - Workflow processes
    - Communication patterns
    - Workforce satisfaction
    - Workforce loyalty
    - Strategic use of IT in decision making ■