Towards an Evaluation Framework for Electronic Health Records Initiatives: An Annotated Bibliography and Systematic Assessment of the Published Literature and Program Reports

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Towards an Evaluation Framework for Electronic Health Records Initiatives:
A Review and Assessment of Methods used to Measure the Impact of
Health Information Systems Projects

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CONTENTS

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BACKGROUND

An Electronic Health Record (EHR) provides each individual with a secure and private lifetime record of their key health history and care within a health system. The record is available electronically to authorized health care providers and the individual anywhere, anytime, in support of high quality care. Recognizing the importance of the EHR in improving the quality and efficiency of health care, the federal government of Canada, in 2001, established Canada Health Infoway to support and accelerate the development and adoption of interoperable Electronic Health Records solutions across the country. Four core components have been identified as the key building blocks of an EHR by Infoway and the Newfoundland and Labrador Centre for Health Information (NLCHI): (1) a unique personal identifier/client registry; (2) a pharmacy network; (3) a laboratory network; and (4) a diagnostic imaging network.

Towards an Evaluation Framework for Electronic Health Records Initiatives: A Review and Assessment of Methods used to Measure the Impact of Health Information Systems Projects, a project funded by Health Canada, Office of Health and the Information Highway, was carried out between May 2002 and December 2003. The goals of the project were to: (a) review current approaches to evaluating the impact of health information systems (particularly those leading to an EHR); and (b) develop an evaluation framework which addresses the information needs of key stakeholders and the identified best practices in the evaluation of such initiatives. Three deliverables were produced from the project and released as separate (but complementary) documents:

1. Towards an Evaluation Framework for Electronic Health Records: An Inventory of Health Electronic Health Records Initiatives Across Canada;
2. **Towards an Evaluation Framework for Electronic Health Records: An Annotated Bibliography and Systematic Assessment of the Published Literature and Project Reports;**
3. Towards an Evaluation Framework for Electronic Health Records: A Proposal for an Evaluation Framework.

This report presents the annotated bibliography and systematic assessment of the published literature and project reports. The project was guided by an advisory committee comprised of key personnel who are leading the work of NLCHI around the development of EHRs, including the Chief Executive Officer, the Health Information Network Project Leader, the Director of Research and Development, the Director of Standards Development and the project's principal research investigator.

SEARCH STRATEGY UTILIZED IN THE LITERATURE REVIEW

The project scope included a systematic assessment of the published literature and program reports to identify existing evaluation approaches and best practices in EHR evaluation. The need for a systematic assessment of the published literature was established subsequent to a thorough search being conducted for published systematic reviews. This search included a review of key databases and consultation with experts in the field of EHRs.

The selection process used in this study was a multi-stage process which involved a broad preliminary selection applied to the citations generated from electronic databases, including MEDLINE, CINAHL, PubMed and the Cochrane Collaborative. Reference lists of retrieved

publications were also searched for relevant citations. Academic librarians were consulted at various stages of the search process.

The initial search included the following search strings:

Information and Communication or “Information and Communication”
Limits: Field - MeSH Major Topic, MeSH Terms fields. Language: English
Publication Periods: 1995-2001

Information Technolog* or “Information Technolog*”
Limits: Field - MeSH Major Topic, MeSH Terms. Language: English
Publication Period: 1995-2001

Communication* Technolog* or “Communication* Technolog*”
Limits: Field – MeSH Major Topic, MeSH Terms. Language – English
Publication Period: 1995-2001

Telehealth or “Telehealth”
Limits: Field – MeSH Major Topic, MeSH Terms. Language – English
Publication Period: 1995–2001

Telemedicine or “Telemedicine”
Limits: Field – MeSH Major Topic, MeSH Terms. Language – English
Publication Period: 1995-2001

Electronic Record or “Electronic Record”
Limits: Field – MeSH Major Topic, MeSH Terms. Language – English
Publication Period: 1995-2001

Information Manage* or “Information Manage*”
Limits: Field – MeSH Major Topic, MeSH Terms. Language – English
Publication Period: 1995-2001

Record* Manage* or “Record* Manage*”
Limits: Field – MeSH Major Topic, MeSH Terms. Language – English
Publication Period: 1995-2001

This initial search strategy was narrowed to exclude articles on telehealth. This decision was based upon the fact that there were numerous other initiatives focusing on telehealth which were ongoing at the time of this study. The search was further refined based upon consultation with the project advisory committee and refinement of the research questions. The following key search terms were identified to form the basis of searching during this phase of the literature review:

Health information system and evaluation
Electronic medical record and evaluation
Electronic patient record and evaluation
Electronic Health Record and evaluation
Health information systems
Electronic patient record
Electronic medical record
Pharmacy and Evaluation
Lab and Evaluation
Diagnostic imaging and Evaluation
Master Patient Index
Patient Master Index

Two Community Health graduate students became involved as the study progressed. Their search strategies were reviewed by the Principal Investigator and the following terms were included in this study:

Clinical notes
Clinical progress notes
Computerized physician order entry
Electronic Prescribing
Laboratory Information System
Laboratory AND electronic exchange
Laboratory AND electronic interchange
Pharmacy Network
Drug Information System

In later stages of the search process and based upon consultation with an academic librarian, a more strategic search strategy was developed using the "thesaurus" and "explode" features of MEDLINE. As an example, in one search, the term "evaluation" was entered and the "explode" feature used to yield numerous related articles. The same feature was used for the key term "medical informatics", which also yielded a number of relevant current articles. Next, the two searches were combined to produce a refined but comprehensive search. These searches resulted in the retrieval of 87 journal articles.

In addition to searching electronic bibliographic indexes, the Google search engine was used to search for evaluation reports of health information systems projects within Canada and internationally. The search was carried out using many of the same key terms used for searching the electronic bibliographic indexes.

The project research assistant also wrote to experts in the field (academics, health information systems' administrators and planners) to solicit additional information about any information (unpublished studies, projects, initiatives) they were aware of and then compared these to the list of journal articles retrieved through the database search. Most of those consulted indicated that there is very little information on the evaluation of geographically dispersed health information systems.

During the course of this project, the Principal Investigator, Dr. Doreen Neville, was a Canadian Associate in the Commonwealth Harkness Program in International Health Policy. Dr. Neville presented the work in progress on this grant in bimonthly forums attended by a number of international health policy experts and sought additional feedback from experts familiar with information system development throughout the year. These contacts were invaluable in helping to identify potentially relevant published and grey literature in this field. Key informants included Dr. Steven Schoenbaum, Vice President of the Commonwealth Fund, who has long standing involvement with health information system development in the US and Dr. Tim Scott, a Harkness Fellow from the UK who was working with Kaiser Pernamente in Hawai to evaluate their health information network. Part of the Harkness experience involved a field trip to the Veteran's Health Complex in Washington DC to learn first hand from key personnel about the experience of building, implementing and evaluating a very sophisticated and continually evolving computerized patient record system. Other Harkness Fellows also provided information about Electronic Health Records initiatives in their respective countries (Australia, New Zealand and the U.K.) and identified additional sources of grey literature on this topic. At the final reporting seminar in Nashville, Tennessee in June 2003, a preliminary evaluation framework was presented and feedback received was incorporated into the framework. The Harkness Fund was helpful also in assisting Dr. Neville to identify a group of experts working in this area in the USA who would be willing to provide feedback on the project, including Drs. David Bates, Ted Shortcliff, and Rob Kolodner; these individuals will be sent a copy of the final report and invited to provide feedback.

INCLUSION/EXCLUSION CRITERIA

After a comprehensive search of both the grey and published literature, a total of 219 articles and project reports were retrieved (textbooks are not included in this count and are referenced separately in the final report). All 219 articles/reports were independently assessed by the Principal Investigator and another member of the project team for inclusion in the annotated bibliography. Where a difference of opinion or uncertainty by either reviewer existed, final consensus was researched by joint review and discussion.

Selection of articles/reports for the annotated bibliography was carried out in two phases:

Phase I: An article was retained if it met each of the following inclusion criteria:

- English in Language
- Published after 1994 (due to the relative currency of the topic)
- Focuses on one (or more) of the four core components of an Electronic Health Record – unique personal identifier/client registry, pharmacy network, laboratory network and diagnostic imaging network
- Describes the evaluation of a health information system project, including presentation of findings

An article was excluded if it:

- Had a technology focus (computer programs and language standards)
- Information system was limited to one location (e.g. within a hospital setting)
- Focused on Telehealth Applications (telehealth applications were beyond the scope of this project)

The first phase of the selection process revealed only 10 articles/project reports that met the inclusion/exclusion criteria.

Phase II: Due to the small number of articles/reports meeting all the inclusion/exclusion criteria, the 219 articles/project reports were re-evaluated. Building upon the work of Freidman and Wyatt (1997) around approaches to the evaluation of health information systems, a comprehensive quality assessment tool (see Appendix A) was developed to critically appraise articles across a range of criteria which were both objectivist and subjectivist in nature. Key considerations in developing the quality assessment tool included:

(1) Relevance: How useful are the findings with respect to the task at hand i.e. do they contribute something new to our understanding of evaluation approaches for complex health information systems?
(2) Rigor: Has a thorough and appropriate approach been applied to key research methods in the study?
(3) Credibility: Are the findings well presented and meaningful?

The results of this critical appraisal are presented in Appendix A.

An article/report was selected for inclusion in the annotated bibliography if it was considered valuable to the development a comprehensive evaluation framework for health information systems projects (i.e. relevant). An article was excluded if it was not able to contribute to the goals of the project or was outside the project scope.

A total of 93 articles/reports were selected for inclusion in the annotated bibliography. Among those selected, 39 articles/reports were research studies (including systematic reviews) that focused on the evaluation of one or more aspects of an Electronic Health Record. These were critically assessed

using the *complete* Quality Assessment Checklist (Appendix A). A further 54 articles/reports discussed an approach to evaluating health information systems projects and therefore were also deemed relevant to the project goals. However, as they did not present the findings of a research study per se, the assessment did not include a review of the scientific rigor of the methodology or the credibility of the research findings.

TRENDS IN THE LITERATURE

Assessment of the published literature and project reports revealed that there is a dearth of information regarding evaluation of geographically dispersed health information systems. Most evaluations of information systems in health care have dealt with relatively small scale initiatives, wherein new technologies replace the existing (usually paper-based) system. The setting for most evaluation studies is within a hospital or a limited hospital to physician office interface (for example, enabling access to lab test results). Search of the literature did not detect a single study that describes the evaluation of a system with all four core components of an Electronic Health Record (EHR).

Reviewed research studies were of varying quality. Many studies lacked rigor with incomplete descriptions of the system under study; others provided detailed information about evaluation methods, instruments and findings which were useful in the development of the proposed evaluation framework. A pre-/post- implementation study design is the most widely agreed upon approach to evaluating health information systems. Many studies identified the use of randomized control trials (RCTs) as being problematic in the evaluation of complex health information systems.

No generic approach to evaluation was identified. Several models have been proposed to guide selected aspects of evaluation activities; most of these are grounded in discipline specific conceptual frameworks. The evaluation framework utilized by the National Health Service in the UK to guide evaluation of electronic patient records (EPRs) and Electronic Health Records (EHRs) provided a template for developing a evaluation framework for Canadian initiatives in EHRs.

ORGANIZATION

Entries are organized into two sections and listed alphabetically within each section. Each citation is followed by: a) a brief annotation addressing the relevance and quality of the article/report, and b) where available, the abstract.

Section I: Discussion documents that focus on an approach to evaluating health information system projects.

Section II: Research studies that focus on the evaluation of a health information systems project.

ABBREVIATIONS

The following is a list of abbreviations that appear in the citations and annotations:

CIS	Clinical Information System
CPIS	Computerized Patient Information System
CPR	Computerized/computer-based Patient Record
EDI	Electronic Data Interchange
EHR	Electronic Health Record
EMR	Electronic Medical Record
EPR	Electronic Patient Record
HIS	Hospital Information System

HMO	Health Maintenance Organization
IS	Information System
IT	Information Technology
NHS	National Health Service, UK
NIS	Nursing Information System
PACS	Picture Archiving and Communication System
POE	Physician/Provider Order Entry
RCT	Randomized Control Trial
VA	Department of Veterans Affairs, USA

ANNOTATE BIBLIOGRAPHY ENTRIES

Section I: Discussion Documents

Alvarez RC, Zelmer J. Standardization in health informatics in Canada. International Journal of Medical Informatics 1998; 48(1-3):13-18.

This article reviews some of the background to and motivation for health information systems initiatives in Canada. Such projects share common goals, such as: (1) integration of information systems to achieve a client focus and health services integration; (2) support for epidemiological research and health systems management; and (3) elimination of duplication and waste, with subsequent improvements in quality of care and reductions in costs. The authors outline proposals for a national health information infrastructure which includes accelerating standards development for managing and exchanging health information.

ABSTRACT: Around the world, informatics has been cited as a key enabler of health sector reform. Recent reform programs in Canada, reflecting this global consensus, have emphasized the importance of quality information and information technology in meeting their goals. Standards are an important building block for achieving the required comprehensive and integrated health information infrastructure. This paper describes the current status of, and future plans for, health informatics and related standards in Canada.

Amatayakul M. Critical success factors - steps to take to achieve a truly integrated information system. Health Management Technology 2000; 21(5):14-18.

This brief paper outlines success factors associated with introduction of a hospital-based computerized patient record system, including the need to: pay attention to the difference between acute care (hospital) and ambulatory care (physician office) needs; understand that connectivity does not equate with service or information integration; and work towards providing knowledge to the provider at the point of care, not just information technology. One table summarizes the differences between the hospital and physician office environments along the dimensions of work flow, primary user, data content, data volume, data source and information flow. A series of questions are presented which, if posed, can enhance the process of evaluating CPR systems.

No abstract available

Anonymous. Computerized provider order entry systems. Health Devices 2001; 30(9-10):323-359.

This article is focused on the technological aspects of CPOE systems. However it also identifies measures used in evaluation of such systems (system interfacing capabilities, patient care safeguards and ease of use and reports).

ABSTRACT: Computerized provider order entry (CPOE) systems are designed to replace a hospital's paper-based ordering system. They allow users to electronically write the full range of orders, maintain an online medication administration record, and review changes made to an order by successive personnel. They also offer safety alerts that are triggered when an unsafe order (such as for a duplicate drug therapy) is entered, as well as clinical decision support to guide caregivers to less expensive alternatives or to choices that better fit established hospital protocols. CPOE systems can, when correctly configured, markedly increase efficiency and improve patient safety and patient care. However, facilities need to recognize that currently available CPOE systems require a tremendous amount of time and effort to be spent in customization before their safety and clinical support features can be effectively implemented. What's more, even after they've been customized, the systems may still allow certain unsafe orders to be entered. Thus, CPOE systems are not currently a quick or easy remedy for medical errors. ECRI's Evaluation of CPOE systems-conducted in collaboration with the Institute for Safe Medication Practices (ISMP) - discusses these and other related issues. It also examines and compares CPOE systems from three suppliers: Eclipsys Corp., IDX Systems Corp., and Siemens Medical Solutions Health Services Corp. Our testing focuses primarily on the systems' interfacing capabilities, patient safeguards, and ease of use.

Bakker AR, Leguit FA. Evolution of an integrated HIS in the Netherlands. International Journal of Medical Informatics 1999; 54(3):209-224.

The development of a hospital HIS in the Netherlands included 2 evaluation studies. The first study addressed the outcome of the project as a whole at one hospital site, and was conducted as a post implementation study, using 150 structured questionnaires and interviews with users from different disciplines and document analysis. Findings included: better quality of care; a relative decrease of costs; an increase in revenue; improved planning capacity; and improved research support. The second study involved a quasi-experimental design to evaluate the impact of the nursing information system. The study involved 3 hospitals (university, general and psychiatric) each with an experimental and control ward, with measurements taken pre-implementation, immediately post implementation and later in the post implementation period. This study focused on the quality of care, coordination of care, job satisfaction and costs. Impact of the NIS on these variables was reported as positive. The authors note the lack of attention paid to evaluation of large scale health information systems projects in Europe and propose a more systematic approach to evaluation be developed to insure effective allocation of resources

ABSTRACT: This article considers the 26 years history of an integrated hospital information system (HIS). The system emerged from an experimental government sponsored project in the Leiden University Hospital and is now the leading HIS in The Netherlands. The evolution during these 26 years is presented and discussed in this article with an emphasis on the organizational setting and financing besides the aspects functionality, technology/architecture and evaluation aspects. Recently HISCOM was acquired by the BAAN-group completing the evolution and bringing the HIS to the international health care IT market.

Bates DW, Gawande AA. Improving safety with information technology. New England Journal of Medicine 2003; 348(25):2526-2534.

This article reviews the major ways in which information technology can reduce the rate of errors: by preventing errors and adverse events; by facilitating a more rapid response after an adverse event has occurred, and by tracking and providing feedback about adverse events. Information technology tools which can contribute to patient safety therefore are those which can: improve communication; make knowledge more accessible, require key pieces of information (such as the use of the drug), perform checks in real time, assist with monitoring and provide decision support. Each of these is discussed in the body of the article.

No abstract available

Bates DW, Pappius E, Kuperman GJ, Sittig D, Burstin H, Fairchild D et al. Using information systems to measure and improve quality. International Journal of Medical Informatics 1999; 53(2-3):115-124.

The Partners Network is an integrated delivery system including 2 large teaching hospitals, smaller community hospitals and a physician network which includes over 700 physicians in the Boston region. At the time the article was written, the Network was in the process of developing a Longitudinal Medical Record (LMR) which would serve as the medical record across the continuum of care for network patients, a master patient index, and a data warehouse which would track both quality measures and resource utilization in comparable ways across the delivery system. This article describes the standard quality measures used at one site and proposes measures to be implemented network-wide. A number of quality indicators are discussed, such as the use of selected measures of efficiency, critical variances and sentinel events by clinical departments and the collection of data hospital wide on nationally recognized indicators such as the Maryland Hospital Indicators and the Health Plan Employer Data and Information Set (HEDIS). Discussion includes numerous examples of how an information system can be employed to measure and enhance quality of care.

ABSTRACT: Information systems (IS) are increasingly important for measuring and improving quality. In this paper, we describe our integrated delivery system's plan for and experiences with measuring and improving quality using IS. Our belief is that for quality measurement to be practical it must be integrated with the routine provision of care and whenever possible should be done using IS. Thus, at one hospital, we now perform almost all quality measurement using IS. We are also building a clinical data warehouse, which will serve as a repository for quality information across the network. However, IS are not only useful for measuring care, but also represent powerful tools for improving care using decision support. Specific areas in which we have already seen significant benefit include reducing the unnecessary use of laboratory testing, reporting important abnormalities to key providers rapidly, prevention and detection of adverse drug events, initiatives to change prescribing patterns to reduce drug costs and making critical pathways available to providers. Our next major effort will be introduce computerized guidelines on a more widespread basis, which will be challenging. However, the advent of managed care in the US has produced strong incentives to provide high quality care at low cost and our perspective is that only with better IS than exist today will this be possible without compromising quality. Such systems make feasible implementation of quality measurement, care improvement and cost reduction initiatives on a scale which could not previously be considered.

Burkle T, Ammenwerth E, Prokosch H, Dudeck J. Evaluation of clinical information systems. What can be evaluated and what cannot? Journal of Evaluation in Clinical Practice 2001; 7(4):373-385.

These authors distinguish several phases of evaluation of software programs, beginning with program development. The phases include: (1) verification - did we build the system correctly; (2) validation - did we build the right system; (3) evaluation of human factors - will the system be accepted and used; and (4) evaluation of clinical effect - impact on patient outcome. Following a critique of methodological approaches to conducting evaluation of human factors and clinical effects, the authors conclude that evaluation is dependent on available resources, goals of the evaluation and the type of technology that is being examined, and a generic approach does not exist. Questionnaires are valuable measurement tools, but will probably need to be modified to fit the system under investigation. While RCTs are the gold standard in evaluation research, their utility in clinical evaluation studies is limited, due to factors such as low power (not enough observations) and inability to blind subjects to their assigned group. However, the authors recommend that good study designs will attempt to introduce some type of control for unwanted effects/confounding variables.

ABSTRACT: The evaluation of clinical information systems is essential as they are increasingly used in clinical routine and may even influence patient outcome on the basis of reminder functions and decision support. Therefore we try to answer three questions in this paper: what to evaluate; how to evaluate; how to interpret the results. Those key questions lead to the discussion of goals, methods and results of evaluation studies in a common context. We will compare the objectivist and the subjectivist evaluation approach and illustrate the evaluation process itself in some detail, discussing different phases of software development and potential evaluation techniques in each phase. We use four different practical examples of evaluation studies that were conducted in various settings to demonstrate how defined evaluation goals may be achieved with a limited amount of resources. This also illustrates advantages, limitations and costs of the different evaluation methods and techniques that may be used when evaluating clinical information systems.

Bush J. Computers: looking for a good electronic medical record system? Family Practice Management 2002; 9(1):50-51.

The criteria proposed for evaluating the " family physician friendliness" of EMR systems are categorized as "basic", "advanced" or "optional". Features of the systems reviewed include: (1) general EMR features; (2) clinical data repository features; (3) medication management capacity; (4) order management capacity; (5) charting/documentation management; (6) results management; (7) office work flow management. A checklist for EMR systems is attached as an appendix.

Too often, family physicians purchase electronic medical records (EMR) systems and are disappointed with their performance. To help physicians better evaluate EMR products before they buy, The AAFP Ad Hoc Committee on Electronic Medical Records created a list of criteria that EMR systems should have in order to be 'family physician friendly'. A portion of the list appears in this article. The complete list of criteria for evaluating EMR systems is available at www.aafp.org/fpnet/x432.html.

DeLone WH, McLean ER. Information systems success: the quest for the dependent variable. Information Systems Research 1992; 3(1):60-95.

This landmark article, focusing primarily on Management Information System (MIS) applications, provides a framework for characterizing and measuring the success of information systems, which includes 6 major dimensions or categories: ***system quality, information quality, use, user satisfaction, individual impact, and organizational impact****. The extensive literature around each of these dimensions is critiqued and summarized and is complemented by tables which highlight the measures used to study each dimension and measurement tools available.* ***System quality measures*** *(measures of the information processing system itself) tend to be engineering-oriented characteristics of the systems under study, such as response time, ease of use, system reliability, system accessibility, system flexibility and system integration.* ***Information quality measures*** *(measures of information system output) are addressed mostly from the perspective of the user and are therefore subjective in nature, such as information accuracy, timeliness, completeness, reliability, conciseness, and relevance. Frequently these measures are included as measures of user satisfaction as well.* ***Measures of information use*** *(recipient consumption of the output of an information system), including self-reported versus documented use, use by whom, frequency of use and extent of use are valid only if system use is voluntary or discretionary.* ***Measures of user satisfaction*** *(recipient response to the use of the output of an information system) are the most widely utilized indicators of system success, primarily because of their inherent face validity, and the availability of reliable measurement instruments, such as satisfaction questionnaires.* ***Individual impact measures*** *(measures of the effect of information on the behavior of the recipient) are strongly tied to measures of performance, such as quality of decision making, change in decision behavior, time efficiency of task accomplishment, time to decision making, and confidence in decision making. Studies of this success indicator, while numerous, are most often undertaken in laboratory settings, using students and computer simulations.* ***Measures of organizational impact*** *(the effect of information on organizational performance) have been derived primarily from the business sector and include cost reduction, cost effectiveness, contribution to profitability and return on investment (ROI).*

The I/S success model is predicated on process and ecology concepts from the organizational effectiveness field, and proposes that success is a process construct which must include both temporal and causal influences on IS success. The authors suggest that there are many success measures which fall into the 6 dimensions described above. They emphasize that it is important to study the interrelationships among these dimensions, and to avoid arbitrarily selecting items from among the 6 dimensions to measure overall success if a clearer understanding of what constitutes information system success is to be achieved. They propose combining measures from the 6 categories to create a comprehensive measurement instrument. Furthermore, they suggest that selection of success measures should consider contingency variables, such as: the independent variables being researched, the size, structure, strategy and environment of the organization being studied, and the characteristics of the system itself.

ABSTRACT: A large number of studies have been conducted during the last decade and a half attempting to identify those factors that contribute to information systems success. However, the dependent variable in these studies - I/S success - has been an elusive one to define. Different researchers have addressed different aspects of success, making comparisons difficult and the prospect of building a cumulative tradition for I/S research similarly elusive. To organize this diverse research, as well as to present a more integrated view of the concept of I/S success, a comprehensive taxonomy is introduced. This taxonomy posits six major dimensions or categories of I/S success – system quality, information quality, use, user satisfaction, individual impact, and organizational impact. Using these dimensions, both conceptual and empirical studies are then reviewed (a total of 180 articles are cited) and organized according to the dimensions of the taxonomy. Finally,

the many aspects of I/S success are drawn together into a descriptive model and its implications for future I/S research are discussed.

DeLone W, McLean E. The DeLone and McLean Model of Information Systems Success: A ten-year update. Journal of Management Information Systems 2003; 19(4):9-30.

This article provides a review of the I/S Success Model (presented earlier) and an overview of how the model has been validated by research in the field. Suggestions for updating the model include; (1)adding a third dimension, "service quality" to the 2 original system characteristics, "system quality" and "information quality"; (2) substituting "intention to use" for "use" as a measure of system usage; and (3) combining the" individual impact" and "system impact" variables into a "net benefits" variable. The "net benefits" variable must be defined within the context of the system under study and the frame of reference of those assessing the system impact, as these variables substantially influence what constitutes net benefits and hence IS success.

ABSTRACT: Ten years ago, we presented the DeLone and McLean Information Systems (IS) Success Model as a framework and model for measuring the complex-dependent variable in IS research. In this paper, we discuss many of the important IS success research contributions of the last decade, focusing especially on research efforts that apply, validate, challenge, and propose enhancements to our original model. Based on our evaluation of those contributions, we propose minor refinements to the model and propose an updated DeLone and McLean IS Success Model. We discuss the utility of the updated model for measuring e- commerce system success. Finally, we make a series of recommendations regarding current and future measurement of IS success.

Donaldson LJ. From black bag to black box: will computers improve the NHS? BMJ 1996; 312(7043):1371-1372.

This editorial notes that many formal evaluations of major information technology investments in the public sector have focused on critiques of implementation rather than health care benefits. The author suggests that the time has come to attempt to quantify benefits not just in organizational, business or financial terms, but also with respect to health outcomes and the intermediary variables which lead to improved health outcomes in the health care delivery system, including improved diagnosis, more effective treatment, more focus on prevention, less errors and more evidence-based decision making. Use of a combination of quantitative and qualitative methods is encouraged.

No abstract available

Doran B, DePalma JA. Plan to assess the value of computerized documentation system: adaptation for an emergency department. Topics in Emergency Medicine 1996; 18(1):63-73.

The process for developing a pre-implementation evaluation plan included identification of expectations for the new system. Anticipated critical benefits identified included: improved accuracy, quality, safety, physician satisfaction, use and satisfaction by support personnel and time savings. Each of the benefits was translated into more specific indicators and measurement tools/approaches for measuring each of the factors. Table 1 summarizes the

evaluation plan in terms of benefits anticipated, indicators, measurement approach and who did the measurement.

ABSTRACT: Computerized documentation systems are becoming the state of the art in acute care settings, but some organizations are struggling with the actual cost versus the perceived utility of the system. The article presents an overview of one organization's evaluation plan to assess the worth of such a computerized system. The benefits assessed were accuracy, quality, safety, and satisfaction. Pre-implementation evaluation results can be used as a rationale for the need for and value of such a system. The plan is presented for its applicability to any care setting, especially the emergency department.

Drazen EL, Little AD, Beyond Cost Benefit: An assessment approach for the 90's. AMIA 1992:113-17.

The authors propose that at least four major efforts enhancements in methodology will be crucial in developing an evaluation approach for the next decade: (1) driving to achieve benefits as the primary evaluation goal (includes more than direct cost savings, i.e. improvement in level of service and improvement in the outcomes of care; (2) focusing on critical issues and using standard tools to achieve efficiencies, i.e. measure what is important, not what is easy to measure; (3) maintaining independence, given the involvement of the private sector in many of the evaluation initiatives; (4) fitting with the institutional philosophy, such as Total Quality Management (TQM) perspectives. They then propose a TQM framework for evaluation which incorporates the concept of continuous quality improvement. An example of a TQM approach to benefits assessment is then outlined: (1) identify improvement opportunities – identify the information processes that need improvement. If a large number of processes are identified, the priorities can be established by considering their importance to a multiple stakeholders; the difficulty in achieving improvement and the strategic importance of improvement; (2) understand priority processes, from the perspectives of relevant stakeholders; (3) find the root cause of the problem; (4) confirm the root cause; (5) identify improvement options; (6) implement solutions; (7) track progress; (8) monitor to insure continuous improvement.

ABSTRACT: A new evaluation approach is needed to evaluate clinical and management applications of H. I. S., where the major benefits may not be related to labor savings. New evaluation approaches also need to reflect a "bottom line" business orientation. We will describe an evaluation approach which is based on TQM concepts and meets both these criteria and incorporates benefits realization into the evaluation process.

Drazen E. Is this the year of the computer-based patient record? Healthcare Informatics 2001; 18(2):94-98.

The central contention of this opinion piece is that "a computer-based patient record, as originally designed, is neither necessary nor sufficient on its own as a tool for improving care". While computerization of medical records will improve access to patient information, the author proposes that 2 important clinical applications which can provide large benefits in terms of patient care are rarely included in CPR systems to date: decision support applications and patient registries. She concludes with a number of recommendations about to move forward in the development of systems which will enhance patient care.

No abstract available

Forsythe DE, Buchanan B. Broadening our approach to evaluating medical information systems. Proc Annu Symp Comput Appl Med Care 1991; 8-12.

This article is somewhat older than the others included in this review, but it makes a number of points with respect to evaluation which are still relevant today. The main theme is that evaluation methods must be employed to measure the social context and organizational environment in which users of a system live and practice. Such methods include quantitative and qualitative approaches and involve multi-disciplinary assessment of not only how users respond to a system but why they do so. In order to examine the way in which a system affects both the user and the pattern of their daily work, pre-implementation assessment of baseline patterns is required.

ABSTRACT: Evaluation in medical informatics tends to follow the paradigm of controlled clinical trials. This model carries with it a number of assumptions whose implications for medical informatics deserve examination. In this paper, we describe the conventional wisdom on evaluation, pointing out some of its underlying assumptions and suggesting that these assumptions are problematic when applied to some aspects of evaluation. In particular, we believe that these assumptions contribute to the problem of user acceptance. We then suggest a broader approach to evaluation, offering some conceptual and methodological distinctions that we believe will be of use to the medical informatics community in rethinking this issue.

Goddard BL. Termination of a contract to implement an enterprise electronic medical record system. Journal of the American Medical Informatics Association 2000; 7(6):564-568.

This article provides a useful summary of lessons learned from a failed attempt to implement an EMR in an integrated health system in New York, consisting of 3 acute care hospitals, a 150 member affiliated multi-specialty group practice in more than 20 locations, nursing homes and home care agencies. The biggest contributing factors to the failure included escalating cost pressures; insufficient attention paid to change management and workflow redesign issues; insufficient engagement and empowerment of clinical leaders and the inexperience of the vendor in the health sector. The authors also point to the need for early and full commitment to the project as a key strategic initiative of the organization, as this type of health information system project is vastly different than the one-site, one application type of intervention many administrators and clinicians are familiar with. Clear identification of the expectations of the system up front, combined with documentation of the types of current work-flow and information sharing processes which need to be changed prior to system implementation are also recommended and would enhance efforts to evaluate the system's impact on the organization post implementation.

ABSTRACT: The development of integrated health care systems, the building of distributed computer networks throughout them, and the advent of easy-to-use electronic medical records for ambulatory practices combine to create a powerful argument for an enterprise electronic medical record. Potential customers need to learn from both successes and failures. Although the author could find in the literature only two reports of failures, a survey of family practice residencies revealed ten programs in which use of an electronic medical record had been discontinued. The author reports on a project that was terminated even though the technology was adequate to achieve the original project goals.

Grant A, Plante I, Leblanc F. The TEAM methodology for the evaluation of information systems in biomedicine. Computers in Biology and Medicine 2002; 32(3):195-207.

This paper reviews the use of information technology in the health care system in biomedical research, clinical care, education and health system management spheres and proposes a generic methodology to evaluate the overall function and impact of an information system. A primary step towards a global methodology is to analyze complexity so that the interaction of an information system with the setting in which it is implemented can be evaluated. A systems perspective informs the model developed by the authors. Key tenets include: (1) the processing of information by a system can be distinguished at 3 different interacting levels: strategic, organizational, and operational, and these levels are a useful way of situating an evaluation; (2) the evaluation should be dynamic and include both formative and summative analyses; (3) the evaluation approach must be acceptable in terms of the resources and time it requires to complete; and (4) the evaluation should be longitudinal. The authors propose that an evaluation exercise should address the (a) who - role categories of persons who should participate in the evaluation; (b) when - time requirements and the timing of stages of evaluation; and (c) what - state the main and sub objectives of the evaluation exercise; the key perspectives which will be addressed, identify measures to be used and to specify the documentation required for the evaluation exercise. Four main role categories are identified: (1) those involved in the conception and design of the information system; (2) those who are responsible for the implementation and functioning of the system (specialist user); (3) those who use the system (end user) and (4) those who have a stakeholder interest that the information system is a success. There is a requirement for a definition of evaluation priorities from each role category's point of view and a recognition by all of the constraints attached to the evaluation process so that the evaluation program is valid and achievable.

ABSTRACT: The TEAM evaluation methodology for information systems in biomedicine (Total Evaluation and Acceptance Methodology) is a unifying methodology for any computer-based information system based on a three dimensional framework; these dimensions being Role, Time and Structure. The theory is derived from how the information system relates to the general system where it should operate, the properties of information flow within a general system and the relation between a system and its models. As a system can in theory be modeled from many perspectives, a perspective to be modeled is built up by formulating criteria relevant to that perspective which can be evaluated by quantitative and qualitative assessment methods. Key characteristics of the methodology include the insistence on a global rather than partial approach to the evaluation of information systems, also the dynamic nature of an information system which is continually in modification as it more successfully deals with the inherent complexity of the environment in which it is operating. The role dimension identifies four main categories, designer, specialist user, end user and stakeholder from which several sub-categories may be identified. The time dimension has four main phases towards relative stability of the information system. The structural dimension distinguishes strategic, tactical or organizational and operational levels that often are confused together with risk of dilution in current approaches. It is believed that this framework and methodology can provide a basis for future standardization of evaluation methodologies.

Green CJ, Moehr JR. Performance evaluation frameworks for vertically integrated health care systems: Shifting paradigms in Canada. Proc AMIA Symp 2000; 315-319.

The major objective of this project was to identify major Canadian performance evaluation frameworks and assess their appropriateness for evaluation of vertically integrated health care systems. In addition, the authors evaluated the frameworks in relation to 2 major trends relevant to the Canadian context; the regionalized health care system and the

emergence of an information info-structure. The frameworks reviewed included those produced by the British Columbia Ministry of Health; the Canadian Council on Health Services Accreditation, the Canadian Institute of Health Information, the functionalist conceptual framework developed by HEALNET, the Ontario Hospital Association and the Toronto District Health Council. Major categories of criteria appear to be well established in the Canadian context as important components of a performance evaluation framework: clinical outcomes/effectiveness; accessibility; customer/stakeholder satisfaction; coordination; financial/efficiency, quality, innovation and learning and internal business production. Less frequently used as framework dimensions were appropriateness, safety, health status and integration. Assessment of the appropriateness of the framework dimensions from an informatics perspective addressed the question "Did the framework address the capabilities of advanced computer information systems optimally?" Most did not, unless in a peripheral way, except for the CIHI framework. The authors conclude by noting that while information system capacity is critical to both evaluation and performance, most existing frameworks do not given this component sufficient focus. Health system performance evaluation frameworks could benefit from (1) being grounded in systems thinking; (2) drawing from quality management approaches to process improvement, and (3) explicitly addressing approaches to developing the required information system capacity.

No abstract available

Hanmer L. Criteria for the evaluation of district health information systems. International Journal of Medical Informatics 1999; 56(1-3):161-168.

This article outlines the approach to be taken to the evaluation of district health information systems in South Africa and describes some of the tools developed to date. Eight categories of evaluation criteria were established, with the most attention paid to the functionality criteria. Criteria which were omitted included costs and benefits and organizational impacts. A handbook, outlining the criteria, and approaches to measurement, was also produced. Preliminary reviews of the draft evaluation instrument suggested that the instrument was too extensive for use by district health service managers for self-assessment of their own information systems. It was also agreed that the evaluation should be a phased approach, so that progress towards the development of a comprehensive information system could be measured. The approach to evaluation was therefore modified to include: (1) identification of core evaluation criteria which could be used either for self assessment by the districts, or as the first phase of the information system evaluation (assessment of the initial status of the health information in the district); and (2) development of evaluation protocols in consultation with staff of the districts in which the evaluation instrument is piloted.

ABSTRACT: A comprehensive set of evaluation criteria for District Health Information Systems (DHISs) in South Africa (SA) have been developed. The criteria are organized in the following eight categories: philosophy and objectives, policy and procedures, functionality, facilities and equipment, DHIS management and staffing, user/patient interaction, staff development and education, and evaluation and quality improvement. A handbook of evaluation criteria has been compiled by restating the evaluation criteria to include mechanisms for measuring whether or not criteria have been met.

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

The authors of this paper outline the problems that have arisen from inappropriate evaluations of clinical information technology, which in their opinion ask inappropriate questions, apply unsuitable methods and incorrectly interpret results. In particular, RCTs have a number of drawbacks, including their cost and limited external validity, in that trial results may not be relevant to the full range of subjects (specific implementation of a health application) or typical uses of a system (p3).They see new directions in evaluation, including the move to multi-perspective, multi-method evaluations which include the use of qualitative methods and diversely constituted research teams. As a final point, they note that evaluation is not just for accountability, but also for development and knowledge building.

No abstract available

Heathfield H, Hudson P, Kay S, Mackay L, Marley T, Nicholson L et al. Issues in the multi-disciplinary assessment of healthcare information systems. Journal of Information Technology and People 1999; 12(3):253-275.

Two of the most difficult general problems of EPR evaluation are: (1) there are many definitions of an EPR and no two EPR implementations are alike, making comparisons difficult; and (2) there is a plethora of possible evaluation questions and it is difficult to decide which ones to address. For the evaluation project discussed in this paper, the team agreed to focus on the form and functionality of the systems implemented (i.e. the concept of total patient record), instead of trying to distinguish for evaluation purposes, the difference between different systems such as EPR and Hospital HIS. They developed agreement as to the 6 most important research questions (presented below in the annotation of the 1997 publication by the same authors titled: Evaluating large scale health information systems: from practice towards theory and developed an evaluation framework to guide their work (presented on p. 265). In the end, however, many team members did not find the framework itself useful, but acknowledged that the process of developing the framework promoted understanding among them as to different philosophies, approaches and methods used in evaluation. Methods used in the main study included: observations, structured and semi-structured questionnaires, and examination of patient records. Problems encountered in the operationalization of the evaluation are outlined and mainly involve the task of integrating the results of the sub-projects/research questions using different methodologies. The authors used a framework to integrate the results which considered the product (the software product itself); the system into which it was implemented and the impact of the product and its use on the organization; this framework was considered to be very subjective and more useful to some members of the team than others. Given the problems with integration of the findings, production of final reports was not straightforward. The authors conclude by noting a number of important lessons learned. These include: (1) these projects exist in the real world and it is not possible to evaluate them against theoretical or academic standards or use pure methods. The goal is to produce as rigorous an evaluation as possible, given the constraints on time, resources, logistics and conflicting cultural, social and political forces, and capacity to adapt is important. A planned evaluation, introduced at the initial project stages, can help overcome many obstacles; (2) much of what they learned was about process issues and application of the findings elsewhere may be problematic; (3) the process of assembling a multi-disciplinary team and working together on this type of complex project is very challenging but also rewarding.

ABSTRACT: Considers the problems of a multi-disciplinary team working together to understand and evaluate a healthcare information system, which itself is situated in a complex organizational and political environment. Provides general discussion of problems faced by evaluators of such systems. Describes this specific evaluation project (Electronic Patient Records in the UK National Health Service), gives an account of the evaluation process as it occurred, highlights some of the problems encountered, and discusses attempts to overcome these. Suggests that social, organizational and political factors are inherent in all such research enterprises, and that in order to facilitate a rich understanding of complex systems, these factors must also be considered as part of the research data.

Heathfield HA, Buchan IE. Current evaluations of information technology in health care are often inadequate. BMJ 1996; 313(7063):1008-1009.

This letter to the editor restates several points made in other publications by the authors regarding the limitations of RCTs in evaluation of complex health information projects and the need to look beyond economic benefits to patient outcomes and improved quality of care. They argue that we have inadvertently created a catch 22 situation, whereby we cannot move forward with information technology in health because of the lack of evaluation, yet our failure to build complex systems and allow them to mature means we have nothing to evaluate (p.1008).

No abstract available

Heathfield HA, Peel V, Hudson P, Kay S, Mackay L, Marley T et al. Evaluating large scale health information systems: from practice towards theory. Proc AMIA Symp 1997; 116-120.

This paper begins with a review of the objectivist/subjectivist approaches to the evaluation of health care information systems as identified by Friedman and Wyatt in 1997. They note that while the use of subjectivist approaches is on the rise, the problem which remains is that today we are faced with the evaluation of large scale health IS projects which are incrementally developed from legacy systems, and hence many methodological and practical problems arise which are different from the issues faced in the past, when evaluations of health IS systems were concerned with relatively small scale initiatives which replace or enhance paper-based records. In their study, 6 evaluation questions were posed: (1) What is the impact of the technology on clinical management at 3 levels, individual patient care, management of services and resource management? (2) What is the impact on the roles, the organization of work and the work satisfaction of staff? (3) Can the cost and benefits be valued? (4) How useful and useable are the patient record systems? (5) What is the relationship between electronic and paper records for the system in relation to availability of data, data integrity, compliance with standards, volume of paper generated and reduction in clerical activity? (6) What is the relationship between the technology and the general management of the organization?

ABSTRACT: With the introduction of large scale health information systems which are incrementally developed from legacy systems, evaluators are faced with difficult methodological and practical problems. Some of the problems involved in multidisciplinary multi-method evaluations care discussed. It is argued that the development of a framework for evaluation is necessary in order to successfully plan an evaluation, understand the implications of the results and make future predictions based upon them. Some suggestions for arriving at such a framework are put forward.

Heathfield HA, Pitty D. Evaluation as a tool to increase knowledge in healthcare informatics. Medinfo 1998; 9(Pt 2):879-883.

Healthfield identifies 3 general categories of perspectives on evaluation: the accountability perspective, the developmental perspective and the knowledge perspective. Current evaluations in clinical informatics however tend to focus on economic benefits and have a preoccupation with RCTs and quantitative approaches. New multi-method approaches are required and priority setting with respect to evaluation questions that will/can be addressed is necessary in resource-constrained times. Nonetheless, 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.

ABSTRACT: The evaluation of information systems is an important topic in Clinical Informatics. It is argued that past evaluations have not been particularly informative in progressing the effective use of IT in healthcare due to their narrow focus. The different roles of evaluation in Clinical Informatics are examined, and the breadth and diversity of the available methodological tool kit highlighted. The aim is to stimulate a greater awareness of the roles and methods of evaluation. Challenges in evaluation which face the Clinical Informatics community are discussed and finally some comments made concerning the way in which evaluation might be made more effective in order to improve our knowledge of how to deliver useful systems into healthcare.

Herbst K, Littlejohns P, Rawlinson J, Collinson M, Wyatt JC. Evaluating computerized health information systems: hardware, software, and human-ware: experiences from the Northern Province, South Africa. Journal of Public Health Medicine 1999; 21(3):305-310.

The evaluation program consisted of 4 separate but inter-linked activities, including: (1) an orientation study, in which expectations of potential users for the system were identified, as well as their views on what the evaluation should address; (2) framework of inquiry, consisting of 10 questions: Are training, change management and support optimal? Is the system itself (hardware, software, peripherals and network) reliable? What is the performance with respect to project management? Does the system improve the communication of patient information between health care facilities? Is data protection adequate? What is the quality and utilization of decision-making information made available for clinicians, hospital management, provincial health executives and the public? Are the patient administration processes more standardized and efficient? Are costs per unit service reduced? Has revenue collection improved? Is information available for audit and/or research use? (3) a workshop to decide on the design of the overall evaluation program, which was primarily a summative evaluation using a RCT; and (4) undertaking the summative evaluation. One important early caution from the ongoing formative evaluation was that in interactive, longitudinal evaluations, evaluators influence the intervention and the people they are evaluating, which is outside the usual RCT/medical research paradigm. The authors recommend that communication between the implementers and the evaluators be carefully thought out and formalized to ensure that the formative components do not invalidate the summative components and the generalizability of the results. Note: for the results of this study, see the annotation for Health Systems Trust, 2002. Evaluation of hospital information system in the Northern Province in South Africa in the research studies section of this document.

ABSTRACT: Despite enormous investment world-wide in computerized health information systems their overall benefits and costs have rarely been fully assessed. A major new initiative in South Africa provides the opportunity to evaluate the introduction of information technology from a global perspective and assess its impact on public health. The Northern Province is implementing a comprehensive integrated hospital information system (HIS) in

all of its 42 hospitals. These include two mental health institutions, eight regional hospitals (two acting as a tertiary complex with teaching responsibilities) and 32 district hospitals. The overall goal of the HIS is to improve the efficiency and effectiveness of health (and welfare) services through the creation and use of information, for clinical, administrative and monitoring purposes. This multi-site implementation is being undertaken as a single project at a cost of R 130 million (which represents 2.5 per cent of the health and welfare budget on an annual basis). The implementation process commenced on 1 September 1998 with the introduction of the system into Mankweng Hospital as the pilot site and is to be completed in the year 2001. An evaluation programme has been designed to maximize the likelihood of success of the implementation phase (formative evaluation) as well as providing an overall assessment of its benefits and costs (summative evaluation).The evaluation was designed as a form of health technology assessment; the system will have to prove its worth (in terms of cost-effectiveness) relative to other interventions. This is more extensive than the traditional form of technical assessment of hardware and software functionality, and moves into assessing the day-to-day utility of the system, the clinical and managerial environment in which it is situated (humanware), and ultimately its effects on the quality of patient care and public health. In keeping with new South African legislation the evaluation process sought to involve as many stakeholders as possible at the same time as creating a methodologically rigorous study that lived within realistic resource limits. The design chosen for the summative assessment was a randomized controlled trial (RCT) in which 24 district hospitals will receive the HIS either early or late. This is the first attempt to carry out an RCT evaluation of a multi-site implementation of an HIS in the world. Within this design the evaluation will utilize a range of qualitative and quantitative techniques over varying time scales, each addressing specific aims of the evaluation programme. In addition, it will attempt to provide an overview of the general impact on people and organizations of introducing high-technology solutions into a relatively unprepared environment. The study should help to stimulate an evaluation culture in the health and welfare services in the Northern Province as well as building the capacity to undertake such evaluations in the future.

Hripcsak G, Wilcox A. Reference standards, judges, and comparison subjects: roles for experts in evaluating system performance. Journal of the American Medical Informatics Association 2002; 9(1):1-15.

This paper focuses on how to use experts in the evaluation of information systems which are designed to produce probabilities of disease, lists of diagnoses, or interventions which are tailored to patients, i.e. decision support tools. It appears that the use of experts is most often employed as a component of formative evaluation during system design and early implementation, particularly in laboratory settings and does not play a substantial role in summative evaluations of systems in the field, where the focus of evaluation tends to be on how /if the system improves performance.

ABSTRACT: Medical informatics systems are often designed to perform at the level of human experts. Evaluation of the performance of these systems is often constrained by lack of reference standards, either because the appropriate response is not known or because no simple appropriate response exists. Even when performance can be assessed, it is not always clear whether the performance is sufficient or reasonable. These challenges can be addressed if an evaluator enlists the help of clinical domain experts. 1) The experts can carry out the same tasks as the system, and then their responses can be combined to generate a reference standard. 2) The experts can judge the appropriateness of system output directly. 3) The experts can serve as comparison subjects with which the system can be compared. These are separate roles that have different implications for study design, metrics, and issues of reliability and validity. Diagrams help delineate the roles of experts in complex study designs.

Kaplan B. Addressing organizational issues into the evaluation of medical systems. Journal of the American Medical Informatics Association 1997; 4(2):94-101.

Social Interactionalist Models consider relationships between system characteristics, individual characteristics and organizational characteristics and the effects among them. Consequently, evaluations based on these models consider not only the impact of an information system on an organization, but also the impact of the organization on the information system, and tend to be process-focused. Evaluation questions within an interactionist framework address issues of Communication, Care, Control and Context (the 4 Cs). The evaluation questions are: (1) what are the anticipated long term impacts on the ways that departments linked by computers interact with each other; (2) what are the anticipated long term effects on the delivery of medical care; (3) will system implementation have an impact on control in the organization; and (4) to what extent do medical information systems have impacts that depend on the practice setting in which they are implemented?

Kaplan suggests that it is difficult to study processes over time and proposes 5 methodological guidelines that can be useful when developing a comprehensive evaluation framework. The evaluation framework should: (1) focus on a variety of technical, economic and organizational concerns; (2) use multiple methods; (3) be modifiable; (4) be longitudinal; and (5) be formative and summative.

ABSTRACT: New system design and evaluation methodologies are being developed to address social, organizational, political, and other non-technological issues in medical informatics. This paper describes a social interactionist framework for researching these kinds of organizational issues, based on research within medical informatics and other disciplines over the past 20 years. It discusses how effective evaluation strategies may be undertaken to address organizational issues concerning computer information systems in medicine and health care. The paper begins with a theoretical framework for evaluation. It then describes the 4Cs of evaluation: communication, care, control, and context. Five methodological guidelines are given for conducting comprehensive evaluations that address these 4Cs. An example of an evaluation research design that fits the guidelines and was used in an evaluation of an on-line clinical imaging system is discussed. Results of the evaluation study illustrate how this approach addresses organizational concerns and the 4Cs.

Kaplan B. Social Interactionist framework for information systems studies: the 4C's. Proc of the IFIP WG 8.2 and 8.6 Joint Working Conference on Information Systems: Current Issues and Future Changes 1998; 327-339.

This paper is very similar to the one reviewed above with respect to outlining an approach to evaluation of clinical information systems.

ABSTRACT: New system design and evaluation methodologies are being developed to address social, organizational, political, cultural, and other non-technological issues in information systems. This paper presents a social interactionist framework for researching these kinds of organizational issues. The framework is influenced by theoretical models of organizational change, user resistance, adoption and use of innovation, and evaluation of information systems, and especially informed by the classic diffusion model based on Rogers's work. It is empirically grounded in research within medical informatics over the past 20 years. The framework discusses how effective evaluation research strategies may be undertaken by focusing on 4Cs of evaluation: communication, care (or, outside a medical setting, delivery of service or production of product), control and context. Three studies illustrate the usefulness of this framework.

Kaplan B, Brennan PF, Dowling AF, Friedman CP, Peel V. Towards an informatics research agenda. Journal of the American Medical Informatics Association 2001; 8(3):235-241.

This article lays out a research agenda model focused on key people and organizational issues in the evaluation of clinical information systems. The model has a 2 dimensional matrix structure. One dimension characterizes the organizational levels of medical informatics use (individuals, institutional, trans-organizational and trans-national). The other dimension includes some of the social science disciplines that are assist in understanding the different organizational levels (individual/cognitive psychology, workgroup/social psychology, organizational sociological and culture/ cultural anthropologist). The cells of the model, presented in Table 1, page 236) include sample questions that could be addressed, using approaches of the indicated social science at the organizational level where they are indicated. The authors caution that the cells in the model appear to examine only how information and information technology impact what goes on, but in view of the social interactionalist perspective of the team, they are also discussing multi-directional influences, i.e. how the impacts of the technology in turn influence the technology. Inclusion of a wide range of research methods and disciplines is an important strength of this research agenda model.

ABSTRACT: As we have advanced in medical informatics and created many impressive innovations, we also have learned that technologic developments are not sufficient to bring the value of computer and information technologies to health care systems. This paper proposes a model for improving how we develop and deploy information technology. The authors focus on trends in people, organizational, and social issues (POI/OSI), which are becoming more complex as both health care institutions and information technologies are changing rapidly. They outline key issues and suggest high-priority research areas. One dimension of the model concerns different organizational levels at which informatics applications are used. The other dimension draws on social science disciplines for their approaches to studying implications of POI/OSI in informatics. By drawing on a wide variety of research approaches and asking questions based in social science disciplines, the authors propose a research agenda for high-priority issues, so that the challenges they see ahead for informatics may be met better.

Kazanjian A, Green CJ. Beyond effectiveness: the evaluation of information systems using a comprehensive health technology assessment framework. Computers in Biology and Medicine 2002; 32(3):165-177.

Although the Comprehensive Health Technology Assessment Framework discussed in this paper is primarily aimed at stakeholders involved in the adoption of new health technologies, the authors propose that it has relevance for decision makers who need to compare the impact of information system technologies within a framework that is inclusive of all competing health technologies. Impacts are considered at the societal level, not just the organizational setting in which the health information system is implemented, and from the perspective of patients and society as primary stakeholders.

ABSTRACT: A Comprehensive Health Technology Assessment Framework is presented as a conceptual tool for decision-making about health technologies, including information technologies. The aim of the model is to provide an empirical, evidence-based foundation for health technology decisions. The major framework dimensions are (1) population at risk, (2) population impact, (3) economic concerns, (4) social context (including ethical, legal, and political concerns), and (5) technology assessment information. This multi-disciplinary approach provides guidelines on use of appropriate information in aligning 'stakeholder wants' and 'population needs'.

Kuhn KA, Giuse DA. From hospital information systems to health information systems: problems, challenges, perspectives. Methods of Information in Medicine 2001; 40(4):275-287.

This paper traces some of the recent developments in health information system development and focuses on issues related to the adoption and implementation of health information systems. Socio-technical and organizational issues are identified as being of central importance to successful implementation of HIS and therefore require significant attention when designing evaluations of HIS. In particular, it is important to determine if the end users (clinicians) perceive the new system as one that enhances their ability to manage patient care, as opposed to one that will automate clinical activities primarily for the benefit of the organization's management.

ABSTRACT: Hospital information systems are evolving towards health information systems. This article aims at identifying both proven benefits and critical issues, and at discussing problems and possible solutions. Significant efforts of all parties involved in the health care process are needed to improve, implement, and evaluate the concepts described.

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

The role that evaluation plays with respect to system design and software development is reviewed, and recommendations for revisions to the Systems Development Life Cycle (SDLC) model, based on the need for iterative design and testing throughout the design process are provided. The role of usability engineering, particularly usability testing (evaluation of information systems though the analysis of typical end users interacting with the system) is discussed, and it is noted that an increasing number of laboratories are applying usability engineering approaches in formative evaluations of information systems. Usability engineering approaches to system development are recommended where user requirements may be difficult to obtain using standard methods (such as interviews and questionnaires) and technical feasibility for some system functions may be unknown (p. 145). The authors predict that as health care applications become more complex, usability engineering approaches are likely to become even more important. Given the trend in health informatics evaluations of moving away from a focus exclusively on measuring outcome variables to evaluations involving collection of in-depth process data, the authors present a framework for cognitive evaluation approaches which encompass a continuum of methods ranging from experiments (laboratory based usability testing where test conditions are tightly controlled), to simulations (laboratory based low and high fidelity simulators) to naturalistic approaches (field based observations using ethnographic methods and unobtrusive recording). The need for future work which will integrate evaluation approaches which examine process variables (such as usability engineering) with approaches which address measurement of outcome variables is highlighted.

ABSTRACT: This paper examines the role of evaluation in the design of health care information systems. A framework is presented for considering evaluation in the context of software development processes, in particular, the systems development life cycle (SDLC). Variations on standard design methodologies are then discussed, including methods based on rapid development and continual evaluation of prototype systems. Usability testing is presented as a key method for conducting evaluations during iterative system development. The emergence of design methodologies, where evaluation is viewed as a central part of the development cycle is also discussed. Evaluation methodologies are then considered along a continuum, ranging from studies involving a high degree of experimental control to observational approaches. A full cycle approach to evaluation of health care systems is argued for, involving deployment of new methods across the SDLC. Implications for future

work exploring the integration of design and evaluation processes in health informatics are discussed.

Kushniruk AW, Patel VL, Cimino JJ. Usability testing in medical informatics: cognitive approaches to evaluation of information systems. Proc AMIA Symp 1997; 218-222.

This paper begins by identifying the need for improved methodologies for the assessment of medical systems and their user interfaces. Conventional methods of evaluation, such as questionnaires and interviews with users, rely on the user's memory of their experience with using a computer system (what they think they did when using the system) which may be quite different from their actual behavior. Therefore, there is a need to incorporate into system design and evaluation processes sound methodologies for the assessment of medical systems and their user interfaces. Methods which can be applied in the study of systems in both the laboratory and real life settings are discussed, including (1) usability testing – evaluation of information systems that involves subjects who are representative of the target user population; (2) cognitive task analysis – characterization of the decision-making and reasoning skills of subjects as they perform activities involving the processing of complex information; and (3) computer supported video analysis - video recording of subjects as they interact with user interfaces in carrying our specific tasks. The 8 steps employed in carrying out cognitive evaluations of health care systems and user interfaces are described, and include (1) development of the test plan; (2) study design, including selection of representative users; (3) selection of representative task /contexts; (4) set up of the test environment; (5) conducting the usability test; (6) data analysis; (7) recommendations to designers; and (8) iterative input to design. The authors note that while cognitively-based usability testing can be applied throughout the lifecycle of information systems (from early formative evaluation during design work to summative evaluation to determine is a computer system has met usability criteria) their experience to date has found that the greatest benefits come from the formative analysis work (p. 221).

ABSTRACT: This paper describes an approach to the evaluation of health care information technologies based on usability engineering and a methodological framework from the study of medical cognition. The approach involves collection of a rich set of data including video recording of health care workers as they interact with systems, such as computerized patient records and decision support tools. The methodology can be applied in the laboratory setting, typically involving subjects "thinking aloud" as they interact with a system. A similar approach to data collection and analysis can also be extended to study of computer systems in the "live" environment of hospital clinics. Our approach is also influenced from work in the area of cognitive task analysis, which aims to characterize the decision making and reasoning of subjects of varied levels of expertise as they interact with information technology in carrying out representative tasks. The stages involved in conducting cognitively-based usability analyses are detailed and the application of such analysis in the iterative process of system and interface development is discussed.

Kushniruk AW, Patel C, Patel VL, Cimino JJ. 'Televaluation' of clinical information systems: an integrative approach to assessing web-based systems. International Journal of Medical Informatics 2001; 61(1):45-70.

This paper describes the author's work on the development and integration of evaluation instruments specifically designed for assessing interaction with web-based information systems in health care. The methods used include (1) on-line data collection, such as on-line questionnaires, on-line commenting facility, tracking patients' usage of Web-based systems accessed from home via a system developed at McGill known as CHECKPOINT;

(2) telephone interviews with users and (3) in-depth video analysis of subjects using the system under study (in a laboratory setting and at remote sites). The instruments are described and examples of distance evaluation are provided.

ABSTRACT: The World Wide Web provides an unprecedented opportunity for widespread access to health-care applications by both patients and providers. The development of new methods for assessing the effectiveness and usability of these systems is becoming a critical issue. This paper describes the distance evaluation (i.e. 'televaluation') of emerging Web-based information technologies. In health informatics evaluation, there is a need for application of new ideas and methods from the fields of cognitive science and usability engineering. A framework is presented for conducting evaluations of health-care information technologies that integrates a number of methods, ranging from deployment of on-line questionnaires (and Web-based forms) to remote video-based usability testing of user interactions with clinical information systems. Examples illustrating application of these techniques are presented for the assessment of a patient clinical information system (PatCIS), as well as an evaluation of use of Web-based clinical guidelines. Issues in designing, prototyping and iteratively refining evaluation components are discussed, along with description of a 'virtual' usability laboratory.

Lau F. Towards a framework for action research in information systems studies. Information, Technology and People 1999; 12, 2: 148-175

Lau notes that action research has been used in social sciences since the 1940s to integrate theory with practice through an iterative process of problem diagnosis, action intervention and reflective learning, but is still not well recognized as a method of inquiry among mainstream IS researchers and journals. The detailed presentation of the Framework for IS Action Research presented in this paper provides both a descriptive view of features of IS action research but also defines the criteria by which action research studies in IS should be conducted and assessed. The four dimensions of the framework: (1) conceptual foundation; (2) study design to describe the methodological details; (3) the research process of diagnosis, actions, reflections and general lessons; and (4) the respective roles of the researcher and participants are described and assessment criteria provided.

ABSTRACT: Based on recent reviews regarding its use in information systems (IS) studies, this paper argues that action research is still not well recognized by action researchers and mainstream IS journals, especially in North America. To make the situation worse, existing criteria used to assess the quality of action research studies are found to be inadequate when applied to IS. In order to advance its understanding and use by IS researchers and practitioners, the IS action research framework proposed recently by Lau is refined and presented as a set of guidelines in this paper. The implications of this refined framework on IS research and practice are discussed

Littlejohns P, Wyatt JC, Garvican L. Evaluating computerised health information systems: hard lesson still to be learnt. BMJ 2003; 326:860-863.

In addition to reporting the results of a failed implementation of a hospital information system in South Africa, this article proposes several reasons why computerized health information systems are prone to failure, including: (1) failure to consider the social and professional cultures of health care organizations; (2) failure to adequately educate users; (3) under-estimation of the complexity of routine clinical and managerial processes; (4)

dissonance among expectations of various stakeholders; (5) reluctance to stop flawed implementation processes; and (6) failure of developer to learn lessons from past projects.

ABSTRACT: Implementation of a hospital information system in Limpopo Province, South Africa failed. Problems arose because of inadequate infrastructure as well as with the functioning and implementation of the system. Evaluation using qualitative and quantitative methods showed that the reasons for failure were similar to those in computer projects in other countries. Reasons for failure included not ensuring users understood the reasons for implementation from the outset and underestimating the complexity of healthcare tasks. Those responsible for commissioning and implementing computerised systems need to heed the lessons learnt to avoid further waste of scarce health resources.

Miller R. Reference standards in evaluating system performance. Journal of the American Medical Informatics Association 2002; 9(1):87-88.

This editorial piece provides commentary on the paper by Hripcsak and Wilcox entitled "Reference Standards, Judges and Comparison Subjects: Roles for Experts in Evaluating System Performance" (JAMA, Jan/Feb 2002) and discusses the question of when experts should be used as part of a system's evaluation. The author proposes that use of experts can be misleading in the absence of a gold standard, and the opinions of experts should be tempered by an attempt to measure the "weight of the evidence" that the experts interpret.

No abstract available

Moehr JR. Evaluation: salvation or nemesis of medical informatics? Computers in Biology and Medicine 2002; 32(3):113-125.

This paper begins with a review of the objectivist and subjectivist approaches proposed by Friedman and Wyatt in 1997, noting that these terms are preferable to the more common terms of quantitative and qualitative methods, as both quantitative and qualitative approaches are used in objectivist and subjectivist research, and the more important distinction is the focus on achieving maximum objectivity versus exploiting subjectivity in the investigation (p.114). Limitations of the objectivist approach to studying the complex world of health information systems include: (1) it is not possible to study the intervention in a vacuum, as health information systems are built to replace or complement existing systems, and instead of evaluating the impact of one new product you are evaluating the dynamic process of adaptation of a new information system; (2) rigorous comparison studies, including RCTs, consume tremendous resources such as time, money and personnel, and the results are often not available in a timeline where input to system redesign is feasible; (3) it is often not possible to adhere to the constraints of RCT design, i.e. it is not possible to randomly select hospitals and fit them with complex information systems in order to study their effects. The subjectivist approach is deemed to hold more promise, in that it addresses what people really want or need to know, attempts to describe the health information system, environment and effects as perceived by people, using detailed observation and inductive reasoning. The most commonly used subjectivist approach in the context of health information system evaluation is a variant of the ethnographic approach, wherein evaluation themes and questions identified based on initial observations and inquiries are pursued iteratively, with increasing detail and adjustment of the direction of pursuit. The advantages of this approach are that it is holistic, economical and can form the basis of design of future objectivist studies. The paper concludes by suggesting that methodological extensions such as: (a) the inclusion of systems engineering approaches in the early phases of system

development, and (b) an assessment of cognitive and social effects in the operational phases is desirable.

ABSTRACT: The currently prevailing paradigms of evaluation in medical/health informatics are reviewed. Some problems with application of the objectivist approach to the evaluation of real - rather than simulated - (health) information systems are identified. The rigorous application of the objectivist approach, which was developed for laboratory experiments, is difficult to adapt to the evaluation of information systems in a practical real-world environment because such systems tend to be complex, changing rapidly over time, and often existing in a variety of variants. Practical and epistemological reasons for the consequent shortcomings of the objectivist approach are detailed. It is argued that insistence on the application of the objectivist principles to real information systems may hamper rather than advance insights and progress because of this. Alternatives in the form of the subjectivist approach and extensions to both the objectivist and subjectivist approaches that circumvent the identified problems are summarized. The need to include systems engineering approaches in, and to further extend, the evaluation methodology is pointed out.

Nazi KM. The journey to e-health: VA healthcare network upstate New York (VISN 2). Journal of Medical Systems 2003; 27(1):35-45.

The VA Healthcare Network Upstate New York is one of 22 Veteran Integrated Service Networks (VISNs) which comprise the Veterans Health Administration arm of the Department of Veteran Affairs. Consisting of 5 principal medical centers, 23 outpatient medical centers, six nursing homes and 2 domiciliary, in 2002 it delivered healthcare to over 97,000 individual patients. Methods used to introduce e-health included (1) benchmarking to assess how the concept of e-health is put into practice; (2) a SWOT (strengths, weaknesses, opportunities and threats) analysis was conducted to identify the factors that impact the implementation of e-health; (3) soliciting user feedback; (4) defining a strategy; and (5) evaluation. Few details are provided with respect to the evaluation plan, except that it appeared to include a ROI analysis as well as qualitative assessments of impact on quality, service and patient convenience.

ABSTRACT: E-Health offers the rich potential of supplementing traditional delivery of services and channels of communication in ways that extend the healthcare organization's ability to meet the needs of its patients. Benefits include enhanced access to information and resources, empowerment of patients to make informed healthcare decisions, streamlined organizational processes and transactions, and improved quality, value, and patient satisfaction. A diverse array of factors affects the development and implementation of e-Health initiatives and applications. Crafting a strategic approach is critical to success, especially in this era of rapidly changing technology. The journey to implementing e-Health at this VA Network is discussed and a model described for assessing the environment, identifying critical success factors, and selecting areas of focus. Recommendations are offered for defining a strategic approach to e-Health for healthcare organizations.

NHS Information Authority, January 2001. Evaluation of electronic patient and health record projects. Prepared by the UK Institute of Health Informatics for ERDIP

This report provides a comprehensive review and reference source of methodologies that may be applied to the evaluation of EPRs and EHRs in the NHS in Britain and Wales. Electronic Patient Record (EPR) describes the record of periodic care provided mainly by one institution, typically an acute care hospital. An Electronic Health Record (EHR) is used

to describe the concept of a longitudinal record of a patient's health and healthcare, from cradle to grave. It combines both the information about patient contacts with primary healthcare as well as subsets of information associated with the outcomes of periodic care held in the EPRs. The guidance presented in this report draws upon a comprehensive literature review of the evaluation methods that have been applied to healthcare applications of IT and EPR/EHRs. This is an excellent reference source for evaluation of health information systems initiatives, particularly those leading to the development of a longitudinal electronic patient health record. A companion report (see reference below) provides a summarized handbook of practical advice and guidance, in the form of an updated version of PROBE.

No abstract available

NHS Information Authority, March 2001. PROBE: Project review and objective evaluation for electronic patient and health records projects. Prepared by the UK Institute of Health Informatics for the NHS Information Authority.

This document is an extension and update of the earlier PROBE guidance issued in 1996 by the NHS and is a companion document to the Evaluation of Electronic Patient and Health Records Projects document released in January 2001 (presented above). It extends the original PROBE document in 2 ways: first by focusing on evaluation questions which are important to EPR/HER projects and secondly by providing more detailed information about how to evaluate, including a review of the various tools and techniques available. *It is a very well organized and thorough presentation of issues surrounding evaluation design and implementation, and its appendices are rich in examples of evaluation questions, methodological approaches and potential measures.*

This guidance suggests that there are 4 essential standards for an evaluation study which need to be tested throughout the evaluation planning stage: utility; feasibility; propriety and accuracy. It also stresses the importance of an evaluation framework, which focuses stakeholders on the expected benefits and barriers of an EPR/HER and methods of measuring these. A suggested format for such a framework is a tabular summation of the following: (1) timing of the review (pre-implementation; implementation and operational); (2) the research objectives/questions the system is designed to test (in the case of the NHS these questions were organized around 5 themes); (3) one or more specific measurement criteria for each research question; (4) the study design to be used; and (5) sources of data to be collected for each measurement criterion.

ABSTRACT (generated from the summary): The purpose of this document is to provide practical guidance for those involved in the evaluation of Electronic Patient and Health Records in the NHS in Britain and Wales Six steps are used to plan evaluation: (1) agree why an evaluation is needed; (2) agree when to evaluate; (3) agree what to evaluate; (4) agree how to evaluate; (5) analyze and report; and (6) assess recommendations and decide on actions. This report covers 3 types of evaluation: (1) pre-implementation reviews of readiness to implement EHRs; (2) implementation reviews that are carried out as part of each stage of the process; and (3) operational evaluations that are carried out on the implemented system, as it is used in practice. The key principles of evaluation emphasized are the need for both formative and summative elements, advanced planning, close integration to the project lifecycle; clearly defined aims and objectives, the inclusion of a before and after (comparative) element, and the collection of quantitative and qualitative data. The report outlines an evaluation framework that addresses structure, process and outcomes along 5 dimensions: strategy, operational, human, financial and technical. For each dimension, some sample evaluation questions are provided. The various evaluation tools and techniques available to evaluators are briefly described, accompanied by an

explanation of how they might be appropriately used and their advantages and disadvantages. These include study designs (before and after versus control and intervention); data collection methods (e.g. questionnaires and focus groups) and also toolkits (e.g. the balanced score card).

NHS Information Authority, March 2003. Electronic Record Development and Implementation Programme update. www.nhsia.nhs.uk/erdip/pages/publications/ERDIPUpdateJan03_5.pdf. Accessed September 2003.

This final ERDIP update brochure provides a brief overview of the approach and achievements of the ERDIP demonstrator sites. Full background on each of the ERDIP pilots, the work they have undertaken, and detailed evaluation of the sites can be found on the ERDIP website at www.nhsia.nhs.uk/erdip.

No abstract available

Ohmann C, Boy O, Yang Q. A systematic approach to the assessment of user satisfaction with health care systems: constructs, models and instruments. Studies in Health Technology and Informatics 1997; 43(Pt B):781-785.

The authors propose that in order to determine the satisfaction of a user with a health information system, two groups of factors have to be distinguished; (1) factors that are dependent on the health care system (satisfaction with the content of the system; satisfaction with the user/system interface and satisfaction with the organization in which the system is implemented) and (2) factors that are independent of the information system, such as attitudes towards computers. The relationship between constructs of computer user research and the general model of user satisfaction with computer systems is outlined and a model of user satisfaction with a computer system is presented. A combination of psychometric instruments is proposed to measure user satisfaction.

ABSTRACT: In this paper an overview is given about research in the field of user satisfaction with health care systems and a new systematic model is set up. The model distinguishes between system-independent and system-dependent factors, the latter characterized by satisfaction with the content, the interface and the organization. Evaluated instruments for assessing user satisfaction are classified according to the model and recommendations for an appropriate use are given.

Protti D, Peel V. Critical success factors for evolving a hospital toward an electronic patient record system: a case study of two different sites. Journal of Healthcare Information Management 1998; 12(4):29-38.

This article outlines the critical success factors associated with the introduction of EPR in 2 very different hospitals in the NHS. Factors contributing to the successful implementation include: (1) a clinical (not just medical) focus; (2) routine clinical use of the system; (3) executive leadership and sound management; (4) nurturing of a new culture; and (5) stability and a mature management-clinical partnership. These findings can provide input into the types of indicators that should be developed to evaluate system implementation in other settings.

No abstract available

Protti D. A proposal to use a balanced scorecard to evaluate information for health: an information strategy for the modern NHS (1998 - 2005). Computers in Biology and Medicine 2001; 32(3):221-236.

The author notes that investments in health information systems are costly ventures and frequently asked questions include concerns about the success of such systems and the degree to which substantial investment has proved worthwhile. Challenges to addressing these concerns include: (1) efficiency (doing things right) is easier to measure than effectiveness (doing the right thing); (2) new systems are intended to change difficult to measure actions; (3) strategic systems elude measurement; and (4) infrastructure investments can not be justified on a ROI basis. He notes that IT infrastructures, like many other public infrastructures such as road, hospitals, sewers, schools etc, require large long term investments and are difficult to cost-justify in advance as well as to show benefits in hindsight (p. 229). However, while in the corporate sector, huge investments in IT have not necessarily produced commensurate profits (possibly because they have not redesigned their business processes to realize the full potential of the technology) in the health sector benefits are being realized. Although the process of building a BSC for a health information systems initiative would not be simple, the author posits that the benefits are worthwhile. A well formulated BSC will include an appropriate mix of outcome measures and performance drivers, and will be formulated in consultation with key stakeholders.

ABSTRACT: The author was invited to assist in the development of an evaluation methodology for the Strategy. One of the conundrums of measuring the information management & technology (IM&T) function is that infrastructure investments cannot be cost justified on a return on investment basis. The balanced scorecard (BSC) is a means to evaluate corporate performance from four different perspectives: the financial perspective, the internal business process perspective, the customer perspective, and the learning and growth perspective. An IM&T BSC for Information for Health was recommended as means of allowing managers to see the positive and negative impacts of IM&T activities on the factors that are important to the NHS as a whole.

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

This article outlines a series of guiding principles and closely aligned premises (which help to define the boundaries of a system by defining what is included and excluded) to guide health information system implementation. The recommended 7 principles and 16 premises draw on the experience of Kaiser Pernamente Colorado, who successfully introduced an electronic health record. While not all of the principles and premises are readily applied to other settings, the take away message is that it is important to develop a process for engaging stakeholders, particularly physicians, in establishing principles and premises for large IS projects.

No abstract available

Protti D. What can the American electronic health record (EHR) pioneers tell us about what it takes to be successful? Healthcare Management Forum 2002; 15(2):33-35.

American electronic pioneers share the experience that their EHR initiatives were viewed as strategic to their organizations and therefore not subjected to cost-benefit or ROI analyses. They were subject to evaluations however, and the expectation was clear from the start that the IS initiatives would not merely automate existing processes, but would, where appropriate, change the way work was done (i.e. direct physician order entry). Advice from successful initiatives includes the need for: support from top management and physicians; active involvement of physicians at all stages of system development and implementation; a focus on supporting clinical care needs, not on technology; and the need for considerable investment in cultural change management.

No abstract available

Sado AS. Electronic medical records in the intensive care unit. Critical Care Clinics 1999; 15(3):499-522.

This paper summarizes the evaluation evidence to date on the impact of EHR systems in the intensive care unit. Impacts measured included (1) changes in time spent in nursing documentation and its impact on direct patient care (generally results show a decrease in time spent in documentation without a corresponding increase in direct patient care); (2) data acquisition and retrieval (concerns include accuracy of data entered and selected, non use of available data on drugs and clinical observations and difficulties in coding and retrieving medical text; (3) use of decision support systems by clinicians and its impact on patient care and organizational costs (most evidence cited supports a finding of increased quality of care and cost savings associated with reduction in preventable drug-related error);and user acceptance of the EMR (results mostly positive for both physicians and nurses).

ABSTRACT: The EMR in the ICU has the utility of providing the necessary information to make sound clinical decisions for critically ill patients. For it to be optimized, the EMR must be more than just what is being replicated in the written record or merely a documentation tool; it must add value that supports and enhances clinical decision support. The EMR is too expensive a tool just to be a computer designed to ease documentation and retrieve data faster. Gardner and Huff have suggested that the EMR must answer three questions: Why, What, and So What. The "Why" is relatively easy to answer, but the "What" data to use so that the information is meaningful to a provider and the "So What" are more difficult to answer. Provided one can qualitatively assess "What" information is important for a health care provider, then "So What" becomes an important objective in the empirical quantification of the benefits that the EMR provides. It is clear that to analyze some of the outcomes that health care delivery provides, one needs some mechanism to automate the information at the point of care, particularly now that the regulatory agencies are requiring it. Given the fact that there is no single integrated computerized patient record, this becomes the daunting task for the next century. Making it easier for health care providers to interact with the system and providing them with instantaneous feedback that changes their medical decision so they can deliver better care (clinical pathways, clinical practice guidelines) will be the task required of the next generation of CISs.

Schiff GD, Rucker TD. Beyond structure-process-outcome: Donabedian's seven pillars and eleven buttresses of quality. Journal on Quality Improvement 2003; 27(3):169-174.

In this article, the authors review the highlights of Avedis Donabedian's contribution to the measurement of quality in health care. Donabedian asserted that quality assurance had 2 components: (1) system design (leading to rough adjustments in performance) and (2) quality monitoring – continuous or periodic performance review, resulting in corrections when necessary (leading to fine tuning of the system). He introduced concepts such as informal and formal quality monitoring, differentiated between implicit and explicit monitoring criteria, and distinguished efficacy from effectiveness. He proposed a 2 dimensional model of structure-process-outcome wherein these variables were on the horizontal axis and on the vertical axis, access, technical quality, affect/relationship quality and continuity of care are identified as areas in which the S-P-O variables are to be applied. Donabedian's seven pillars of quality included: efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity. His eleven buttresses of quality assurance included: interdependency, organizational dependency, consensuality, congruence, credibility, relevance, ownership, mutuality of interest, facilitation, coerciveness and virtue (personal and public).

No abstract available

Snaedal J. The ethics of health sector databases. EHealth International 2002; 1(1):6-8.

This commentary outlines some of the ethical issues which were raised when the Icelandic government proposed, in the spring of 1998 a bill which would introduce a central health sector database, containing all health information produced in the communication of physicians with all the country's patients. It was also planned that all other health information produced in health institutions be transferred to the database, and that a private sector company would have exclusive right of use of the database for a long time. This bill was developed without widespread consultation and was eventually withdrawn and resubmitted and passed in December 1998. However the development of the database has not proceeded as expected, and the case prompted the development of a declaration of patients' rights with respect to health information databases. Some of the main points include: (1) patients have the right to be informed when their information is being shared with a third party, even when they have no ability to oppose the sharing of the information; (2) generally a patient can oppose the transfer of information about him/her to an indicated database and only in exceptional cases will he/she be unable to oppose; (3) only in exceptional cases will information be transferred to a database without consent; (4) a patient should be able to trust that his physician will not give his personal health information to others; and (5) if a patient initially agrees to the transfer of information to a database and later changes his/her mind, the patient should have the right to demand that the data be deleted if it is technically possible.

No abstract available

Talmon J, Enning J, Castaneda G, Eurlings F, Hoyer D, Nykanen P et al. The VATAM guidelines. International Journal of Medical Informatics 1999; 56(1-3):107-115.

The VATAM (validation of telematics applications in medicine) project was established to provide support to validation of telematics projects in Europe. The VATAM guidelines consist of 2 components: (1) a document that describes the general approach to

assessment as proposed by VATAM; and (2) a searchable repository that will allow users to find information about terminology, methodologies, etc. The guidelines adopted the working definition of evaluation proposed by Friedman and Wyatt (1997) wherein evaluation is divide into 2 phases: (1) measurement and observation of the information resources through the different phases of development (formative evaluation) and (2) measurement and observation of the performance of the information resources and the behavior of people who in some way use the results of these resources (summative evaluation). In VATAM they include in the second stage also the impact that the system may have on the organization in which it is used, the outcome of health care provision and the economic impact.

ABSTRACT: Evaluation and assessment of the impact of information and communication technology in medicine is gaining interest. Unfortunately, till now there were no agreed upon approaches. The objective of the VATAM project is to develop guidelines that will assist assessors to set-up and execute studies. This paper describes the background of the VATAM project and provides an account of the current state of the guidelines. It concludes with an indication of the developments that will take place in the short term to further elaborate the guidelines and some considerations for consolidation of VATAM's results.

Treweek S, Flottorp S. Using electronic medical records to evaluate healthcare interventions. Health Informatics Journal 2001; 7(2):96-102.

Approximately 90% of GPs in Norway use EMRs, and there are essentially only 3 EMR products in use in the country. Currently, none of the 3 products offer a simple and flexible way to extract data from the EMR database, which led to the development of extraction software called QTools. Examples of the types of data that can be extracted from the EMRs include patient characteristics, diagnostic information, contact type and prescriptions. Experience to date suggests that the data quality within EMRs in Norway is still a largely unknown quantity. Without a gold standard (an assessment of the true state of the patient) it is difficult to assess the completeness and accuracy of information contained in the EMRs. Strategies to increase the quality of information available include reimbursement of MDs for completing infrequently field that are deemed essential (i.e. lifestyle data for health promotion activities).

ABSTRACT: Successive Norwegian governments have introduced a number of health reforms that aim to make better use of resources while improving patient care. One of the most recent reforms, the Regular General Practitioner (GP) Scheme, will introduce a general practitioner list system across Norway. The government plans an evaluation of this reform. One project within the evaluation will develop a system for the collection of 'activity data' within primary healthcare. The intention is that these data will give an overview of what is happening within the primary healthcare sector and facilitate planning of services. Routine data stored in GPs' electronic medical record systems (EMRSs) will be the major source of this activity data. Indeed, collection of these activity data may become a permanent feature of primary healthcare monitoring in Norway. This paper presents one method for obtaining these data and gives examples of the sort of data that are available in the EMRS. Finally, the paper discusses some of the problems that may be encountered when using EMRS data for evaluation of healthcare interventions. The greatest challenges in this field are unlikely to be technical or organizational, but human. In other words, what is the best way to encourage GPs to collect high quality data?

Waegemann CP. The five levels of the ultimate electronic health record. Healthcare Informatics 1995; 12(11):26-35.

This paper describes the evolution of the electronic health record: automated medical records; computerized medical records; electronic medical records; electronic or computer-based patient record systems; and the electronic health record and provides a useful description of the meanings of these terms which are sometimes incorrectly used interchangeably.

No abstract available

Zender A. Where are they now? CPR leaders assess their progress. Journal of AHIMA 2000; 71(8):35-39.

In 1995, the first 3 organizations to be recognized for their leadership in the development of computer-based patient records were Columbia-Presbyterian Medical Center, New York City, NY, Intermountain Health Care, Salt Lake City, Utah, and the Department of Veterans Affairs, Washington, DC. This article provides a highlight of their progress 5 years later. In Columbia-Presbyterian, the system evolved to become part of a web-based Internet system known as WebCIS. Clinicians can now access data off site and patients can transmit their own health status data and access their own records. User acceptance was enhanced by an extensive process to inform users of changes, and progress is monitored by weekly meetings with user groups and an on-line suggestion box. One of the major goals for the future is to address medical errors using the decision support system. In Intermountain Health Care, the main development has been to evolve from a hospital information system towards a longitudinal system which includes an outpatient perspective and a complete view of the patient in many different settings. Their system is also relying less on mainframe technology and more on internet technology, including the development of a wide area network (WAN). Efforts continue in the area of improving quality of care, including development of a data warehouse populated by clinical data, stripped of identifiers. The Department of Veterans Affairs has seen its system enhance patient care, research and education, and enable decision support tools that enhance patient safety. They have applied internet technology to the intranet in their wide-spread organization to provide real time access to information clinical information and decision support at the point of care. The VA has a strong history of user acceptance due to its one-to-one training and regular updates. Future directions include having the patient themselves be the person with the most complete lifelong medical record of their care, and movement towards a more modular information system that is open standards-based, interoperable and portable.

ABSTRACT: Five years ago the first recipients of the Davis awards showed us success of CPR systems across the country. Where are they now? This article catches up with these CPR leaders.

Section II: Research Studies

Adams WG, Mann AM, Bauchner HB. Use of an electronic medical record improves the quality of urban pediatric primary care. Pediatrics 2003; 111:626-632.

Examines the quality of care at a pediatric primary care centre before and after implementation of an EMR system. Quality of documentation used as a proxy for care delivered. Uses survey and chart review. Survey carried out during post-implementation

component only. Shorter study period and smaller sample size during pre-implementation study. Authors were also system developers.

ABSTRACT; Objective: To evaluate the quality of pediatric primary care, including preventive services, before and after the introduction of an electronic medical record (EMR) developed for use in an urban pediatric primary care center. Methods: A pre-/post-intervention analysis was used in the study. The intervention was a pediatric EMR. Routine health care maintenance visits for children <5 years old were reviewed, and documentation during pre-intervention (paper-based, 1998) and post-intervention visits (computer-based, 2000) was compared. Results: A total of 235 paper-based visits and 986 computer-based visits met study criteria. Twelve clinicians (all attending or nurse practitioners) contributed an average of 19.4 paper-based visits (range: 5-39) and 7 of these clinicians contributed an average of 141 computer-based visits each (range: 61-213). Computer-based clinicians were significantly more likely to address a variety of routine health care maintenance topics including: diet (relative risk [RR]: 1.09), sleep (RR: 1.46), at least 1 psychosocial issue (RR: 1.42), smoking in the home (RR: 15.68), lead risk assessment (RR: 106.54), exposure to domestic or community violence (RR: 35.19), guns in the home (RR: 58.11), behavioral or social developmental milestones (RR: 2.49), infant sleep position (RR: 9.29), breastfeeding (RR: 1.99), poison control (RR: 3.82), and child safety (RR: 1.29). Trends toward improved lead exposure, vision, and hearing screening were seen; however, differences were not significant. Users of the system reported that its use had improved the overall quality of care delivered, was well-accepted by families, and improved guidance quality; however, 5 of 7 users reported that eye-to-eye contact with patients was reduced, and 4 of 7 reported that use of the system increased the duration of visits (mean: 9.3 minutes longer). All users recommended continued use of the system. Conclusion: Use of the EMR in this study was associated with improved quality of care. This experience suggests that EMRs can be successfully used in busy urban pediatric primary care centers and, as recommended by the Institute of Medicine, must play a central role in the redesign of the US health care system.

Bates DW, Teich JM, Lee J, Seger D, Kuperman GJ, Ma'Luf N et al. The impact of computerized physician order entry on medication error prevention. Journal of the American Medical Informatics Association 1999; 6(4):313-321.

Bates and colleagues examine the impact of physician order entry with decision support on reducing medication errors within an inpatient setting. Uses a prospective time series analysis, including pre-implementation measurements. Offers substantial detail on evaluation approach, data collection and analysis. Findings have implications for the design of computerized order entry systems.

ABSTRACT: Background: Medication errors are common, and while most such errors have little potential for harm they cause substantial extra work in hospitals. A small proportion do have the potential to cause injury, and some cause preventable adverse drug events. Objective: To evaluate the impact of computerized physician order entry (POE) with decision support in reducing the number of medication errors. Design: Prospective time series analysis, with four periods. Setting and Design: All patients admitted to three medical units were studied for seven to ten-week periods in four different years. The baseline period was before implementation of POE, and the remaining three were after. Sophistication of POE increased with each successive period. Intervention: Physician order entry with decision support features such as drug allergy and drug-drug interaction warnings. Main outcome measure: Medication errors, excluding missed dose errors. Results: During the study, the non-missed-dose medication error rate fell 81 percent, from 142 per 1,000 patient-days in the baseline period to 26.6 per 1,000 patient-days in the final period ($P < 0.0001$). Non-intercepted serious medication errors (those with the potential to cause injury)

fell 86 percent from baseline to period 3, the final period (P = 0.0003). Large differences were seen for all main types of medication errors: dose errors, frequency errors, route errors, substitution errors, and allergies. For example, in the baseline period there were ten allergy errors, but only two in the following three periods combined (P < 0.0001). Conclusions: Computerized POE substantially decreased the rate of non-missed-dose medication errors. A major reduction in errors was achieved with the initial version of the system, and further reductions were found with addition of decision support features.

Birkmeyer CM, Bates DW, Birkmeyer JD. Will electronic order entry reduce health care costs? Effective Clinical Practice 2002; 5(2):67-74.

Examines costs and savings associated with electronic order entry systems. Identifies implementation and on-going cost components. Provides little detail regarding methodological approach. Analysis based on theoretical implementation, cost/savings estimates and synthesis of literature.

No abstract available

Bomba D, de Silva A. An Australian case study of patient attitudes towards the use of computerised medical records and unique identifiers. Medinfo 2001; 10(Pt 2):1430-1434.

Study of patient attitudes towards computerized medical records and unique identifiers, using a survey design. Limited to one practice setting. Identifies indicators for evaluation including: impact on information management and efficiency, impact on quality of care received, ownership, access, storage and security Little detail on data analysis. Findings presented as descriptive statistics.

ABSTRACT: Research into patient attitudes towards the use of technology in health care needs to be given much greater attention within health informatics. Past research has often focused more on the needs of health care providers rather than the end users. This article attempts to redress this knowledge bias by reporting on a case study of the responses gained from patients in a selected Australian medical practice towards the use of computerised medical records and unique identifiers. The responses (n=138) were gained from a survey of patients over a 13 day period of practice operation. This case study serves as an example of the type of future consumer health informatics research which can be undertaken not just in Australia but also in other countries, both at local regional levels and at a national level.

Branger P, Duisterhout J. Electronic data interchange in medical care: an evaluation study. Proc Annu Symp Comput Appl Med Care 1991; 58-62.

Evaluation of electronic data interchange (EDI) between geographically dispersed sites using a pre- and post- implementation design. Sample limited to GPs while information system connects GP offices, pharmacies and hospitals. Study instruments include surveys and measures of timeliness. Not all pre- and post- implementation measures are comparable. Measures were taken to protect the privacy of study participants.

ABSTRACT: This paper describes the evaluation of the first phase of the Communication Project Apeldoorn (COPA). The aim of COPA was to investigate the contribution of

Electronic Data Interchange (EDI) to quality of care and practice efficiency. In this project over 33 general practitioners (GPs), 12 pharmacists and two hospitals (with one management) participated. In order to limit the number of variables for the evaluation study a limited number of messages was implemented: free-text messages between GPs; admission/discharge reports from hospitals to GPs, laboratory test reports from hospital to GP. The goal of the evaluation of the first phase of the project was to study message flow, the effect of integration with the Electronic Medical Record and the use of those data for patient care. In order to compare the use of EDI with the original situation (i.e. regular mail) a baseline study was performed. In this study the procedure for handling laboratory test reports and admission/discharge reports was also investigated. The results of the baseline study were compared with the evaluation of the use of EDI.

Branger P, van der Wouden, Schudel B, Verboog E, Duisterhout J, van der Lei J et al. Electronic communication between providers of primary and secondary care. BMJ 1992; 305(6861):1068-1070.

Comparison of a paper-based system and an electronic system for communication of laboratory reports and admission-discharge reports between hospitals and GP offices. Uses a pre- and post- implementation design, however tools and measures used in the evaluation of the paper-based system and the electronic system not always comparable. Article directly related to preceding article by Branger.

ABSTRACT: Objective: To study the effects of the introduction of electronic data interchange between primary and secondary care providers on speed of communication, efficiency of data handling, and satisfaction of general practitioners with communication. Design: Comparison of traditional paper based communication for laboratory reports and admission-discharge reports between hospital and general practitioners and electronic data interchange. Setting: Twenty-seven general practitioners whose offices were equipped with a practice information system and two general hospitals. Outcome measures: Paper based communication was evaluated by questionnaire responses from and interviews with care providers; electronic communication was evaluated by measuring time intervals between generation and delivery of messages and by assessing doctors' satisfaction with electronic data interchange by questionnaire. Results: Via paper mail admission-discharge reports took a median of 2-4 days, and laboratory reports 2 days, to reach general practitioners. With electronic data interchange almost all admission-discharge reports were available to general practitioners within one hour of generation. When samples were analyzed on the day of collection (as was the case for 174/542 samples in one hospital and 443/854 in the other) the laboratory reports were also available to the general practitioner the same day via electronic data interchange. Fifteen general practitioners (of the 24 who returned the questionnaire) reported that the use of electronic admission-discharge reports provided more accurate and complete information about the care delivered to their patients. Ten general practitioners reported that electronic laboratory reports lessened the work of processing the data. Conclusion: Electronic communication between primary and secondary care providers is a feasible option for improving communication.

Chin HL, McClure P. Evaluating a comprehensive outpatient clinical information system: A case study and model for system evaluation. Proc Annu Symp Comput Appl Med Care 1995; 717-721.

Evaluation of the pilot implementation of an outpatient clinical information system (CIS) in two medical offices in the Northwest Region of Kaiser Permanente. Evaluation based on criteria for a successful system as perceived by the investigators. Post-implementation study only. Offers little detail on study instruments, data collection and analysis. Decision made to regionalize the system based on results of the pilot implementation evaluation.

ABSTRACT: Decisions about information system implementation are often justified through a cost-benefit analysis. The ability to improve efficiency and outcomes while decreasing costs through information systems - by allowing for multiple and instant simultaneous access to information, through data monitoring and altering, through automation of protocols, and by collecting information for population-based health care as opposed to individual illness-care - are all potential benefits of a comprehensive clinical information system. Measuring the quantitative impact of these system improvements, however, is difficult. Doing a complete cost-benefit analysis of a comprehensive clinical information system is unrealistic due to the many assumptions necessary and the multiple confounding factors that are involved. In our Clinical Information Systems deployment in Kaiser Permanente, Northwest Region, we have elected not to do a detailed cost-benefit analysis. Instead, we have done an evaluation, based on success criteria, of a pilot implementation of a vendor-supplied system. This evaluation is based on clinician acceptance, system usage, technical factors, and quantitative effects on physician productivity. We also considered qualitative factors such as relationship with and responsiveness of the system vendor. We are moving ahead to regionalize this clinical information system based on such an evaluation of our pilot project. This paper outlines the approach that we have taken in evaluating our implementation of this system. It may provide some guidance for organizations on how to make a decision about whether or not to regionalize a clinical information system based on the evaluation of a pilot-site implementation.

Darbyshire P. User-friendliness of computerized information systems. Computers in Nursing 2000; 18(2):93-99.

An exploration of users' perceptions of and experiences with computerized patient information systems (CPIS), using qualitative methods. Not an evaluation of a particular product or system. Sample included nurses and midwifes across a wide range of clinical areas. Substantial detail on sample recruitment, data collection and analysis. Emphasizes the value of a qualitative approach in uncovering and interpreting end-users' experiences.

ABSTRACT: Despite the plethora of research on nurses and the use of computers and information systems, there have been few attempts to examine the everyday experiences of nurses who use such systems in practice. This qualitative study builds on our limited understanding of practitioners' experiences regarding use of Computerized Patient Information Systems (CPIS). Focus group interviews were held across Australia with practitioners from a wide range of clinical settings and specialties. The study findings suggest that participants were predominantly critical of systems in almost every area related to "user-friendliness." The perspectives and views of practitioners are important to understand if future generations of CPIS hardware and software are to be developed with a greater appreciation of the needs of the system's front-line users.

Effler P, Ching-Lee M, Bogard A, Ieong MC, Nekomoto T, Jernigan D. Statewide system of electronic notifiable disease reporting from clinical laboratories. Journal of the American Medical Association 1999; 282(19):1845-1850.

Compares timeliness and completeness of reporting for an electronic and paper-based system for transmitting laboratory reports for notifiable diseases to a state Department of Heath. Reports transmitted simultaneously through both systems. One-way flow of information only. Identifies potential benefits and challenges when implementing a system to electronically exchange information between heterogeneous systems at geographically separate locations.

ABSTRACT: Context: Notifiable disease surveillance is essential to rapidly identify and respond to outbreaks so that further illness can be prevented. Automating reports from clinical laboratories has been proposed to reduce underreporting and delays. Objective: To compare the timeliness and completeness of a prototypal electronic reporting system with that of conventional laboratory reporting. Design: Laboratory-based reports for 5 conditions received at a state health department between July 1 and December 31, 1998, were reviewed. Completeness of coverage for each reporting system was estimated using capture-recapture methods. Setting: Three statewide private clinical laboratories in Hawaii. Main outcome measure: The number and date of reports received, by reporting system, laboratory, and pathogen; completeness of data fields. Results: A total of 357 unique reports of illness were identified; 201 (56%) were received solely through the automated electronic system, 32 (9%) through the conventional system only, and 124 (35%) through both. Thus, electronic reporting resulted in a 2.3-fold (95% confidence interval [CI], 2.0-2.6) increase in reports. Electronic reports arrived an average of 3.8 (95% CI, 2.6-5.0) days earlier than conventional reports. Of 21 data fields common to paper and electronic formats, electronic reports were significantly more likely to be complete for 12 and for 1 field with the conventional system. The estimated completeness of coverage for electronic reporting was 80% (95% CI, 75%-85%) compared with 38% (95% CI, 36%-41%) for the conventional system. Conclusions: In this evaluation, electronic reporting more than doubled the total number of laboratory-based reports received. On average, the electronic reports were more timely and more complete, suggesting that electronic reporting may ultimately facilitate more rapid and comprehensive institution of disease control measures.

Gadd CS, Penrod LE. Assessing physician attitudes regarding use of an outpatient EMR: A longitudinal, multi-practice study. Proc AMIA Symp 2001; 194-198.

Details pre- and post- implementation assessment of physicians' attitudes towards an outpatient EMR in six practices of a large academic health system in the US. Objectives and findings clearly stated. Survey includes items from validated instruments as well as items developed for the study. Discusses the importance of timing in evaluating new technologies due to a period of adjustment following implementation.

ABSTRACT: A pre - and post - implementation assessment of physician attitudes was undertaken as part of the evaluation of the pilot implementations of an outpatient EMR in 6 practices of a large academic health system. Our results show that these physicians are ready adopters of computer technology when it demonstrates value-added for the effort required to use it. These physicians utilize email, the Internet, remote access to computer systems, and personal productivity software because they serve a valuable purpose in their academic and clinical work and in their personal lives. Much more critical to the acceptance of an EMR by physicians is its ability to facilitate efficient clinical workflows without negative effects on the valued relationships physicians have with their patients - those that are based on rapport, quality of care, and privacy.

Gamm L, Barsukiewiez C, Dansky K, Vasey J. Pre- and post- control model research on end-users' satisfaction with an electronic medical record: preliminary results. Proc AMIA Symp 1998; 225-229.

Focuses on end-user attitudes before and after implementation of an EMR system in the PennState Geisinger Health System. Identifies indicators for evaluation including: helpfulness for improving office conditions such as medical records problems, tests, consults, patient waits, care reminders and billing; computer utility including impact on quality, efficiency and productivity associated with patient care and administrative practices, communication, finance and staffing; and computer anxiety including confidence in learning

new computer skills and discomfort with computer jargon. Sample includes physicians, nurses and support staff. Uses triangulation of qualitative and quantitative methods to validate findings. Findings limited to preliminary results for post-implementation component. Highlights the importance of formative evaluation for identifying difficulties during system implementation.

ABSTRACT: This study reports early results of a project that addresses the process of computerizing medical records in multiple ambulatory care sites of a health system. The study focuses on end-user attitudes before, during, and after implementation, through the use of questionnaires, interviews, and participant observation. Knowledge about end-user attitudes prior to computerization may contribute to planning for the training and implementation process. Tailoring these processes to meet the varying needs of user groups may result in a higher level of functional use of the system and less stress to the persons involved in its use. One implementation plan may not work for all sites when there are differences in size of the clinic, work flow patterns prior to implementation, and computer experience among personnel. Preliminary analysis of post-installation questionnaires and interviews six months after the installation point to a number of areas that might be usefully addressed in future installation efforts.

Hassey A, Gerret D, Wilson A. A survey of validity and utility of electronic patient records in a general practice. BMJ 2001; 322(7299):1401-1405.

Assesses whether data contained in an electronic health record is an accurate record of a patients health events. Outlines criteria for measuring validity of functional areas and clinical entries in an EHR. Limited to one practice setting and short study period.

ABSTRACT: Objective: To develop methods of measuring the validity and utility of electronic patient records in general practice. DESIGN: A survey of the main functional areas of a practice and use of independent criteria to measure the validity of the practice database. Setting: A fully computerised general practice in Skipton, north Yorkshire. Subjects: The records of all registered practice patients. Main outcome measures: Validity of the main functional areas of the practice clinical system; measures of the completeness, accuracy, validity, and utility of the morbidity data for 15 clinical diagnoses using recognized diagnostic standards to confirm diagnoses and identify further cases; development of a method and statistical toolkit to validate clinical databases in general practice. Results: The practice electronic patient records were valid, complete, and accurate for prescribed items (99.7%), consultations (98.1%), laboratory tests (100%), hospital episodes (100%), and childhood immunizations (97%). The morbidity data for 15 clinical diagnoses were complete (mean sensitivity=87%) and accurate (mean positive predictive value=96%). The presence of the Read codes for the 15 diagnoses was strongly indicative of the true presence of those conditions (mean likelihood ratio=3917). New interpretations of descriptive statistics are described that can be used to estimate both the number of true cases that are unrecorded and quantify the benefits of validating a clinical database for coded entries. Conclusion: This study has developed a method and toolkit for measuring the validity and utility of general practice electronic patient records.

Hawkins F. Evaluation of clinical documentation before and after EMR implementation. IT Health Care Strategist 2000; 2(12):8-11.

Compares documentation of clinical notes in a paper-based medical record system and an EMR. Pre- and post- implementation design. Poorly structured publication. Little detail regarding data collection and analysis. Offers select findings only.

No abstract available

Hippisley-Cox J, Pringle M, Cater R, Wynn A, Hammersley V, Coupland C et al. The electronic patient record in primary care - regression or progression? A cross sectional study. British Medical Journal 2003; 326(7404):1439-1443.

Examines the content and quality of paperless medical record systems used by GPs in the United Kingdom. Compares paper-based records and electronic medical records using chart audit and GP interviews. Cross-sectional study design. Substantial detail on sample recruitment, data collection and analysis. Findings limited to descriptive statistics.

ABSTRACT: Objectives: To determine whether paperless medical records contained less information than paper based medical records and whether that information was harder to retrieve. DESIGN: Cross sectional study with review of medical records and interviews with general practitioners. Setting: 25 general practices in Trent region. Participants: 53 British general practitioners (25 using paperless records and 28 using paper based records) who each provided records of 10 consultations. Main outcome measures: Content of a sample of records and doctor recall of consultations for which paperless or paper based records had been made. Results: Compared with paper based records, more paperless records were fully understandable (89.2% v 69.9%, P=0.0001) and fully legible (100% v 64.3%, P < 0.0001). Paperless records were significantly more likely to have at least one diagnosis recorded (48.2% v 33.2%, P=0.05), to record that advice had been given (23.7% vs. 10.7%, P=0.017), and, when a referral had been made, were more likely to contain details of the specialty (77.4% v 59.5%, P=0.03). When a prescription had been issued, paperless records were more likely to specify the drug dose (86.6% v 66.2%, P=0.005). Paperless records contained significantly more words, abbreviations, and symbols (P < 0.01 for all). At doctor interview, there was no difference between the groups for the proportion of patients or consultations that could be recalled. Doctors using paperless records were able to recall more advice given to patients (38.6% v 26.8%, P=0.03). Conclusion: We found no evidence to support our hypotheses that paperless records would be truncated and contain more local abbreviations; and that the absence of writing would decrease subsequent recall. Conversely we found that the paperless records compared favorably with manual records.

Jerant AF, Hill DB. Does the use of electronic medical records improve surrogate patient outcomes in outpatient settings? Journal of Family Practice 2000; 49(4):349-357.

Systematic review focusing on the effectiveness of EMRs as tools for improving surrogate patient outcomes. Research question revised after initial review revealed no publications examining the impact of EMRs on morbidity and mortality. Broad time frame (1966 - 1999). Presents scale used for assessing article quality. Findings indicate the need for a more rigorous standard for EMR research.

ABSTRACT: Objective: We reviewed the evidence regarding the effectiveness of electronic medical records (EMRs) as tools for improving surrogate patient outcomes in the outpatient primary care setting. Methods: We searched the MEDLINE database (1966-1999) to find relevant articles for inclusion in the systematic review. Reference lists of retrieved publications were also searched for relevant citations. We included original published reports of all prospective studies evaluating the use of hybrid or complete EMR systems as a method of improving surrogate patient outcomes in the outpatient primary care setting. Criteria for evaluation included the use of a random study group assignment, appropriateness of control group, blinded assessment of outcomes, number and reasons for withdrawal of subjects, and attempts to minimize confounding interventions. Results:

Seven prospective trials of complete EMRs and 9 prospective trials of hybrid EMRs were located. Most evaluated the impact of EMR-generated reminders on provider and patient compliance with health maintenance interventions. Findings were equally positive for both complete and hybrid EMRs, and all but 1 trial reported positive results. However, the methodologic quality of the trials was modest. Design problems included lack of concurrent control groups, non-blinded outcome assessment, and the presence of potentially confounding concurrent interventions. Conclusions: Evidence from published trials suggests that utilization of either complete or hybrid EMRs can improve some surrogate outpatient care outcomes. However, rigorous trials that evaluate their impact on morbidity and mortality, and employ current technologies are required before widespread adoption of EMRs can be confidently recommended.

Kaplan B, Lundsgaarde HP. Toward an evaluation of an integrated clinical imaging system: identifying clinical benefits. Methods of Information in Medicine 1996; 35(3):221-229.

Pilot implementation evaluation of a clinical imaging system that is integrated with an online electronic health record at a VA hospital. Uses a qualitative approach to investigate clinical benefits as perceived by clinicians. Among the benefits identified are: patient care benefits including improved clinical communication and decision making, more patient-based care, reduction in procedures and patient risk, and improved medical record keeping; and educational benefits including improved communication, providing students with real experience and improved supervision. Identified benefits can be developed into more specific indicators for further evaluation using quantitative methods. Discusses the value of using multiple methods for evaluating information systems. Post-implementation study only. Extensive information on data collection and analysis.

ABSTRACT: Integrated clinical imaging systems can provide the foundation for future computer-based patient record systems as recommended by the Institute of Medicine. However, documenting the benefits of such systems is difficult. This paper reports an evaluation of a clinical imaging system that is integrated with an on-line electronic patient record. The evaluation used interviews and observations to identify what physicians thought were the benefits of this system. Reported benefits may be classified into patient care benefits, educational benefits, and productivity and cost-reduction benefits Physicians said that the imaging system provided patient care benefits by: improving clinical communication and decision making, making care more patient-based, reducing the number of procedures and patient risks, and improving record keeping. Educational benefits they reported included: improving communication, providing broad "real" experience, and improving supervision. These benefits may be reflected in increased productivity and cost reduction by increasing time savings, reducing clerical work, improving morale, and reducing the costs of care. The approach described in this study was valuable in identifying potential benefits of a clinical information system. The findings point the way to realization of benefits for other systems, and, ultimately, for computer-based patient records.

Keshavjee K, Troyan S, VanderMolen D. Measuring the success of electronic medical record implementation using electronic and survey data. Proc AMIA Symp 2001; 309-312.

Examines workflow and practice efficiency before and after EMR implementation within independent family physician clinics. Some clinics receive laboratory results electronically, but no other link to outside systems. Pre- and post- implementation design. Collects self-reported estimates of time spent on administrative and physician tasks, using a separate survey of physicians and support staff. Indicators include: time spent preparing day sheets, pulling charts, writing in charts and billing (administrative tasks) and time spent writing in

charts, prescription writing, reviewing consult reports and reviewing lab reports (physician tasks). Provides little detail regarding sample recruitment, data collection and analysis.

ABSTRACT: Computerization of physician practices is increasing. Stakeholders are demanding demonstrated value for their Electronic Medical Record (EMR) implementations. We developed survey tools to measure medical office processes, including administrative and physician tasks pre- and post-EMR implementation. We included variables that were expected to improve with EMR implementation and those that were not expected to improve, as controls. We measured the same processes pre- EMR, at six months and 18 months post-EMR. Time required for most administrative tasks decreased within six months of EMR implementation. Staff time spent on charting increased with time, in keeping with our anecdotal observations that nurses were given more responsibility for charting in many offices. Physician time to chart increased initially by 50%, but went down to original levels by 18 months. However, this may be due to the drop- out of those physicians who had a difficult time charting electronically.

Kozyrskyj A, Brown T, Mustard C. Community pharmacist perceptions of a provincial drug utilization database. Canadian Pharmaceutical Journal 1998; 131:24-29.

Focuses on community pharmacist perceptions of the Manitoba Drug Programs Information Network (DPIN), an electronic point-of-sale prescription claims database linking all community pharmacies in the province. Survey of community pharmacists using stratified random sampling. Addresses functionality, barriers and optimal use. Identified benefits (drug therapy monitoring, identification of drug-related problems and acceptance by clients and physicians) and barriers (including difficulty obtaining client personal health identification number, insignificant drug warnings, interference with customer service, inadequate training, lack of public education and lack of reimbursement) can be used as indicators in future evaluations. Little detail regarding data analysis. Post-implementation study only.

ABSTRACT: A survey of 118 community pharmacists in Manitoba, Canada was conducted to determine their impressions of the newly established Drug Programs Information Network (DPIN), a point-of-sale drug utilization data base linking all community pharmacies in the province. Overall, 80% of pharmacists agreed that the DPIN system benefited their practice. A large majority of pharmacists also agreed that drug therapy monitoring was important to their practice and that the DPIN helped them identify drug-related problems for their clients. Less than 50% of pharmacists said that training on the system was sufficient, and three-quarters of respondents agreed that lack of pharmacist reimbursement was a barrier to using DPIN.

Kozyrskyj AL, Mustard CA. Validation of an electronic, population-based prescription database. Annals of Pharmacotherapy 1998; 32(11):1152-1157.

Assesses the quality of data contained in a population-based prescription database for conducting research. Uses original prescriptions as a gold standard for measuring data accuracy. Substantial information on data collection and analysis. Findings suggest that certain populations may be underrepresented when prescription submission is discretionary.

ABSTRACT: Background: The Drug Programs Information Network (DPIN), Manitoba's (Canada) new electronic prescription database, is a valuable data source for pharmacoepidemiologic research. Pharmacies are required to submit to the DPIN all

prescriptions for Pharmacare, the province's drug insurance plan, but submission of prescriptions for social assistance recipients and treaty status Indians is discretionary. Objective: The completeness of the DPIN prescription database was assessed to determine whether treaty status Indians and social assistance recipients were underrepresented. Design: Prescriptions dispensed during March 13-17, 1995, in a stratified sample of Manitoba pharmacies were linked to DPIN by prescription number to determine the proportions submitted for Indian Affairs, Social Services, and Pharmacare recipients. Pharmacare records in the DPIN were compared with original pharmacy records to evaluate data accuracy. Results: Of 2196 Indian Affairs and 1879 Social Services prescriptions dispensed in 58 pharmacies, a corresponding prescription was found in the DPIN for 79.7% (98% CI 78.0% to 81.4%) and 90.1% (98% CI 88.8% to 91.4%) of prescriptions, respectively. These proportions were significantly lower than the estimated proportion of Pharmacare prescriptions submitted (93%, 98% CI 92.4% to 93.6%). Ninety-two percent of 8012 DPIN Pharmacare prescriptions matched the original prescription on the drug name, quantity, and days' supply. Conclusions: This study established that the DPIN is a valid and reliable data source for studying prescription use among the majority of Manitoban residents. However, the DPIN database has differential validity and under represents prescriptions dispensed for the aboriginal population.

Krall MA. Acceptance and performance by clinicians using an ambulatory electronic medical record in an HMO. Proc Annu Symp Comput Appl Med Care 1995; 708-711.

Outlines the approach taken to evaluate the pilot implementation of an ambulatory clinical information system at 2 primary care clinics in Kaiser Permanente Northwest Region (KPNWR). Uses a pre- and post- implementation design. Little detail regarding data collection and analysis. Findings are presented for select items only. Authors note that system implementation occurred simultaneously with other major initiatives which may have influenced acceptance of the system.

ABSTRACT: The Northwest Region of Kaiser Permanente implemented a comprehensive clinical information system in two sites between February and December 1994. By year end 46 primary care clinicians and 95 supporting personnel used the system on a daily basis to provide patient care. Clinicians use the product to select coded diagnoses, and directly order laboratory, imaging, and other tests, internal referrals, and prescriptions. They enter progress notes into the system, and use it to generate patient focused visit summaries. Clinicians took approximately 2 minutes longer, on average, to complete patient visits post-implementation. Most of this time was spent performing "orders and diagnosis" work, which included new required elements in the post-implementation period. Clinicians worked approximately 30 days before reaching their baseline visit rate and "lost" approximately 48 hours of productivity during the learning, including classroom training. User acceptance improved from 2 to 4 months of use.

Larrabee JH, Boldreghini S, Elder-Sorrells K, Turner Z, Wender RG, Hart JM et al. Evaluation of documentation before and after implementation of a nursing information system in an acute care hospital. Computers in Nursing 2001; 19(2):56-65.

Compares completeness of documentation in hospital patient charts before and after implementation of a computerized nursing information system. Strong methodological approach - time series design with three time points. Detailed information on study instrument and data collection. Data collectors were staff nurses which may have introduced bias into the data collection process. Limited to three units within an inpatient setting.

ABSTRACT: Economic pressures on healthcare systems have intensified the necessity of demonstrating the unique contribution of nursing care to patient outcomes. The use of nursing information systems (NIS) has increased completeness of some nursing documentation elements. This study's purpose was to evaluate differences in documentation completeness of nurse assessments of patient outcomes (NASSESS), achievement of patient outcomes (NGOAL), nursing interventions done (NQUAL), and routine assessments before and after implementation of an NIS in a 100-bed urban university hospital in west Tennessee and before and after retraining in NIS use and care planning. NIS implementation did not improve documentation within the first six months. However, retraining and continued NIS use did significantly improve NASSESS, NGOAL, NQUAL, and blood pressure documentation 18 months post-implementation. Nurses must evaluate documentation completeness before and periodically after NIS implementation, using results to improve patient record data validity for patient care decisions, quality improvement, and research.

Lau F, Hebert M. Experiences from health information system implementation projects reported in Canada between 1991 and 1997. Journal of End User Computing 2001; 13(4):17-25.

Focuses on the outcome of health information system projects in Canada through literature review and author interviews. Includes articles published in the COACH Conference proceedings between 1991 and 1997. Clear focus with good presentation and discussion of findings. Identifies lack of evaluation as a major shortcoming of health information systems projects.

ABSTRACT: Canada's Health Informatics Association has been hosting annual conferences since the 1970's as a way of bringing information systems professionals, health practitioners, policy makers, researchers and industry together to share their ideas and experiences in the use of information systems in the health sector. This paper describes our findings on the outcome of information systems implementation projects reported at these conferences in the 1990s. Fifty implementation projects published in the conference proceedings were reviewed and the authors or designates of 24 of these projects were interviewed. The overall experiences, which are consistent with existing implementation literature, suggest the need for organizational commitment; resource support and training; managing project, change process and communication; organizational/user involvement and teams approach; system capability; information quality; and demonstrable positive consequences from computerization.

Lock C. What value do computers provide to NHS hospitals? BMJ 1996; 312(7043):1407-1410.

Literature review focusing on the value of computer systems to NHS hospitals. Includes British literature published between 1990 and July 1995. Study goals and objectives unclear. Offers little detail regarding search strategy and data collection. Presents criteria for assessing level of detail provided with respect to costs and benefits in papers on hospital information systems. Not limited to EHR systems. Conflict of interest declared by author.

ABSTRACT: As the NHS spends around pond 220 million a year on information technology for use by acute hospitals that are hard pressed for resources, it is reasonable to ask what value is provided. A review of rigorous scientific evidence for the value of information technology to NHS hospitals found that published evidence is scarce and far from conclusive. Information technology in NHS hospitals needs further assessment so that

future decisions on such necessary and important investments are based on clear, well documented experience and research.

Marshall PD, Chin HL. The effects of an electronic medical record on patient care: clinician attitudes in a large HMO. Proc AMIA Symp 1998; 150-154.

Describes the evaluation of a comprehensive outpatient EMR system implemented throughout the Kaiser Permanente Northwest Region. Cross-sectional study design using a combination of quantitative and qualitative methods. Post-implementation study only. Study sample includes physicians, physician assistants, nurse practitioners, optometrists and mental health professionals. Indicators include overall quality of care, quality and content of patient-clinician interaction, ability to act on test results in a timely manner, ability to coordinate patient care with other providers, ability to adhere to practice guidelines and detection of medication errors. Few details provided with respect to data collection and analysis.

ABSTRACT: Objective: The purpose of this study is to examine the attitudes of clinicians in a large HMO toward the effect of an outpatient Electronic Medical Record system on the quality of patient care. Attitudes toward a Results Reporting system and an online charting and ordering system are also compared. Design: A cross-sectional study was performed using a survey of Kaiser Permanente Northwest clinicians. In addition, interviews were conducted with the physician leaders of the clinical departments at Kaiser Permanente Northwest. Measurements: Clinician attitudes are measured regarding the effects of a Results Reporting system and an online charting and ordering system on the overall quality of patient care and other care-related indices. Results: Most clinicians feel that the outpatient Electronic Medical Record has improved the overall quality of patient care, with 72% reporting an improvement with the use of the Results Reporting system, and 60% reporting an improvement with the use of the online charting and ordering system. On average, clinicians feel that the EMR has also improved the quality of the patient-clinician interaction, the ability to coordinate the care of patients with other departments, the ability to detect medication errors, the timeliness of referrals, and the ability to act on test results in a timely fashion. Conclusion: Clinicians perceive an improvement in patient care as a result of using an outpatient Electronic Medical Record system. Clinicians have higher opinions, however, of the effects of a Results Reporting system compared to an online charting and ordering system.

Mbananga N, Madale R, Becker P. Evaluation of hospital information system in the Northern Province in South Africa. Report prepared for the Health Systems Trust, 2002, Medical Research Council of South Africa.

Project report describing the evaluation of the Hospital Information System (HIS) as it was being implemented across the Northern Province of South Africa. Originally designed as a RCT but changed to a before and after study due to unplanned unequal randomization. Detailed methodology includes quantitative and qualitative components. Data were collected at baseline pre-implementation and 6 months post-implementation. Successes and failures were assessed by considering the objectives set for the project pre-implementation. High level hospital performance indicators used to evaluate the HIS included: median time outpatients spend at hospital; average length of stay, bed occupancy, number of drug prescriptions per patient, improved revenue collection, cost per patient per day, and number of referrals. Despite originally high expectations for the quantitative component of the project, the qualitative component recognized as most valuable data source for interpreting the quantitative findings and assessing HIS impact.

Lessons learned from system implementation and evaluation are presented, the most notable of which are: (1) it is difficult to use routine hospital performance indicators to assess HIS, especially if the system is not implemented in a form that was originally intended; and (2) there is a need for more multi-center, multi-method evaluations in this field.

No abstract available

Medical Records Institute, 2003. Overview of the MRI fifth annual survey of EHR trends and usage. www.medrecinst.com/resources/survey/results03/index.shtml

International survey of electronic health record trends and usage. Includes 1150 participants from a range of healthcare and information systems related disciplines. Overview of results only. Unable to critique methods.

ABSTRACT: The MRI Survey of EHR Trends and Usage reveals insights into the management, administrative, and clinical motivations driving the need for Electronic Health Record systems; EHR applications and functions being implemented or planned; IT platforms used to support EHR applications; EHR configurations for different environments; data capture methods being employed; major barriers to EHRs and the user strategies to address them and data security concerns.

Mitchell E, Sullivan F. A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980 - 1997. BMJ 2001; 322(7281):279-282.

Systematic review of studies examining the use of computers in primary care. Literature published from 1980 to 1997. Includes studies examining the impact of computers on practitioner performance, patient outcomes and practitioner and patient attitudes. Scoring system developed to assess methodological adequacy. Did not strictly adhere to Cochrane standards to avoid excluding less rigorous but useful studies. Findings indicate a dearth of studies evaluating effects of computers on patient outcomes.

ABSTRACT: Objective: To appraise findings from studies examining the impact of computers on primary care consultations. Design: Systematic review of world literature from 1980 to 1997. Data sources: 5475 references were identified from electronic databases (Medline, Science Citation Index, Social Sciences Citation Index, Index of Scientific and Technical Proceedings, Embase, OCLC First Search Proceedings), bibliographies, books, identified articles, and authors active in the field. 1892 eligible abstracts were independently rates, and 89 studies met the inclusion criteria. Main outcome measures: Effect on doctors' performance and patient outcomes; attitudes towards computerization. Results: 61 studies examined effects of computers on practitioners' performance, 17 evaluated their impact on patient outcome, and 20 studied practitioners' or patients' attitudes. Computer use during consultations lengthened the consultation. Reminder systems for preventive tasks and disease management improved process rates, although some returned to pre-intervention levels when reminders were stopped. Use of computers for issuing prescriptions increased prescribing of generic drugs, and use of computers for test ordering led to cost savings and fewer unnecessary tests. There were no negative effects on those patient outcomes evaluated. Doctors and patients were generally positive about use of computers, but issues of concern included their impact on privacy, the doctor-patient relationship, cost, time, and training needs. Conclusions: Primary care computing systems can improve practitioner performance, particularly for health promotion interventions. This may be at the expense of patient initiated activities,

making many practitioners suspicious of the negative impact on relationships with patients. There remains a dearth of evidence evaluating effects on patient outcomes.

Murff HJ, Kannry J. Physician satisfaction with two order-entry systems. Journal of the American Medical Informatics Association 2001; 8(5):499-509.

Compares physician satisfaction with the human-computer interface of two order entry systems with similar capabilities – a commercially available product and the Department of Veterans Affairs Computerized Patient record System (CPRS). Discusses evaluation approach and identifies indicators used in the evaluation of the human-computer interface including overall reaction to the software, screen design and layout, terminology and systems information, learning and system capabilities. Uses validated instruments. Participants experienced with both systems, but amount of experience differed among systems and physicians. Substantial information on data collection and analysis.

ABSTRACT: Objectives**:** In the wake of the Institute of Medicine report, To Err Is Human: Building a Safer Health System (LT Kohn, JM Corrigan, MS Donaldson, eds; Washington, DC: National Academy Press, 1999), numerous advisory panels are advocating widespread implementation of physician order entry as a means to reduce errors and improve patient safety. Successful implementation of an order entry system requires that attention be given to the user interface. The authors assessed physician satisfaction with the user interface of two different order entry systems - a commercially available product, and the Department of Veterans Affairs Computerized Patient Record System (CPRS). Design and measurement: A standardized instrument for measuring user satisfaction with physician order entry systems was mailed to internal medicine and medicine -pediatrics house staff physicians. The subjects answered questions on each system using a 0 to 9 scale. Results: The survey response rates were 63 and 64 percent for the two order entry systems. Overall, house staff were dissatisfied with the commercial system, giving it an overall mean score of 3.67 (95 percent confidence interval [95%CI], 3.37 - 3.97). In contrast, the CPRS had a mean score of 7.21 (95% CI, 7.00 - 7.43), indicating that house staff were satisfied with the system. Overall satisfaction was most strongly correlated with the ability to perform tasks in a "straightforward" manner. Conclusions: User satisfaction differed significantly between the two order entry systems, suggesting that all order entry systems are not equally usable. Given the national usage of the two order entry systems studied, further studies are needed to assess physician satisfaction with use of these same systems at other institutions.

Sittig DF, Kuperman GJ, Fiskio J. Evaluating physician satisfaction regarding user interactions with an electronic medical record system. Proc AMIA Symp 1999; 400-404.

Examines satisfaction with an EMR among primary care physicians in a single hospital setting. Post-implementation survey using the QUIS, a standardized general user evaluation questionnaire. Identifies indicators and specific survey items used to evaluate the human-computer interface. Indicators include overall user reactions, screen design and layout, terms and system information, learning and system capabilities. Participants asked to consider only three system applications when completing the survey. Descriptive statistics clearly stated. Correlation results not as explicit. Authors conclude with key points to consider when designing an EMR interface.

ABSTRACT: A limiting factor in realizing the full potential of electronic medical records (EMR) is physician reluctance to use these applications. There have been very few formal usability studies of experienced physician users of EMRs in routine clinical use. We distributed the Questionnaire for User Interaction Satisfaction (QUIS) to 75 primary care

physicians who routinely use the Brigham and Women's Integrated Computing System (BICS). BICS scored highest in the area of screen design and lowest in the area of system capability. Overall user satisfaction was most highly correlated with screen design and layout, and surprisingly not with system response time. Human-computer interaction studies can help focus our design efforts as we strive to increase clinician usage of information technology.

Thiru K, Hassey A, Sullivan F. Systematic review of scope and quality of electronic patient record data in primary care. BMJ 2003; 326(7398):1070-1075.

A Systematic review of data quality in electronic patient records in primary care. English literature published between 1980 and 2001. Uses multiple data sources. Study selection criteria clearly stated. Includes studies that used a reference standard for assessment of quality. Authors suggest that comparison between studies is difficult due to a lack of standardized methods for assessing data quality.

ABSTRACT: Objective: To systematically review measures of data quality in electronic patient records (EPRs) in primary care. Design: Systematic review of English language publications, 1980-2001. Data sources: Bibliographic searches of medical databases, specialist medical informatics databases, conference proceedings, and institutional contacts. Study Selection: Studies selected according to a predefined framework for categorizing review papers. Data extraction: Reference standards and measurements used to judge quality. Results: Bibliographic searches identified 4589 publications. After primary exclusions 174 articles were classified, 52 of which met the inclusion criteria for review. Selected studies were primarily descriptive surveys. Variability in methods prevented meta-analysis of results. Forty eight publications were concerned with diagnostic data, 37 studies measured data quality, and 15 scoped EPR quality. Reliability of data was assessed with rate comparison. Measures of sensitivity were highly dependent on the element of EPR data being investigated, while the positive predictive value was consistently high, indicating good validity. Prescribing data were generally of better quality than diagnostic or lifestyle data. Conclusion: The lack of standardized methods for assessment of quality of data in electronic patient records makes it difficult to compare results between studies. Studies should present data quality measures with clear numerators, denominators, and confidence intervals. Ambiguous terms such as "accuracy" should be avoided unless precisely defined.

Twair AA, Torreggiani WC, Mahmud SM, Ramesh N, Hogan B. Significant savings in radiologic report turnaround time after implementation of a complete picture archiving and communication system (PACS). Journal of Digital Imaging 2000; 13(4):175-177.

Evaluates the effects of PACS implementation on radiology turnaround time (TAT), in an Ireland hospital. Pre- and post-implementation design. Other changes in the department at the time of PACS implementation complicate any before-and-after comparison. Limited to a single setting and relatively small sample size.

ABSTRACT: One of the important advantages of the picture archiving and communication system (PACS) is the time saved in comparison with the conventional system. A group of 100 radiologic studies done in a conventional radiology department is compared with another group of the same number done in a completely filmless PACS department to assess the difference in the radiologist report turnaround time. There was a statistically significant ($P < .00001$) decrease in the median imaging-to-dictation time (IDT) of the PACS group (3 hours and 40 minutes) in comparison with the pre-PACS group (25 hours and 19 minutes). This can be attributed to the fact that PACS eliminates all the workload

associated with hard copy films, thus, improving the department's efficiency and decreasing the number of lost films.

van der Loo RP, van Gennip EMSJ, Bakker AR, Hasman A, Rutten FFH. Evaluation of automated information systems in health care: an approach to classifying evaluative studies. Computer Methods and Programs in Biomedicine 1995; 48(1-2):45-52.

Literature review with classification of evaluative studies of automated information systems in health care. Not specific to EHR systems. Provides details regarding classification approach. Suggests that classification of evaluation studies can offer insight into as to why certain study designs are preferred for information system evaluation while other designs are not.

ABSTRACT: In this paper we discuss an approach to classifying evaluative studies of automated information systems in health care. Selected literature (76 studies) is classified according to the type of automated information system (based on relationship to the care process), the study design used, the data collection methods used, the effect(s) measured and the type of evaluation (e.g. cost-benefit analysis). First results show that certain types of automated information systems have not been evaluated much, going by the number of studies selected. Furthermore, it is observed that certain study designs (time-series design), data collection methods (modeling and simulation) and effect measures (job satisfaction) are hardly to be found in the literature. Only 10 of 76 selected studies used a type of evaluation for which both consequences and costs are considered. Detailed investigation of the literature may provide information for the development of a general framework for the evaluation of different types of automated information systems.

Van der Meijden MJ, Tange HJ, Hasman TA. Determinants of success of inpatient clinical information systems: a literature review. Journal of the American Medical Informatics Association 2003; 20(3):235-243.

Literature review focusing on evaluation studies of patient care information systems. Limited to inpatient information systems. Includes English and Dutch literature published between 1991 and May 2001. Attributes of success categorized according the DeLone and McLean framework of information systems success. Discusses important considerations for the evaluation of patient information systems.

ABSTRACT: We reviewed the English and Dutch literature on evaluations of patient care information systems that require data entry by health care professionals published from 1991 to 2001. Our objectives were to identify attributes that were used to assess the success of such systems and to test the ability of a framework developed by Delone and McLean for management information systems to categorize these attributes correctly. The framework includes six dimensions or success factors: system quality, information quality, usage, user satisfaction, individual impact, and organizational impact. Thirty-three papers were selected for complete review. Types of study design included descriptive, correlational, comparative, and case studies. A variety of relevant attributes could be assigned to the six dimensions in the Delone and McLean framework, but some attributes, predominantly in cases of failure, did not fit any of the categories. They related to contingent factors, such as organizational culture. Our review points out the need for more thorough evaluations of patient care information systems that look at a wide range of factors that can affect the relative success or failure of these systems.

Wager KA, Ornstein SM, Jenkins RG. Perceived value of computer-based patient records among clinical users. M D Computing 1997; 14(5):334-340.

Examines the perceived value of a computer-based patient record (CPR) system among clinician users. All participants use the same CPR system at independent sites. A single contact person completed a survey on behalf of the entire practice. Post-implementation study only. Survey developed by authors for the study. Results presented as descriptive statistics. Identifies indicators for evaluation including: quality of patient record, access to patient record, utility or ease of use, security, efficiency, and administrative costs.

No abstract available

Wager KA, Lee FW, White AW, Ward DM, Ornstein SM. Impact of an electronic medical record system on community-based primary care practices. The Journal of the American Board of Family Practice 2000; 13(5):338-348.

Assesses the impact of an EMR on five community-based primary care practices. Post-implementation study involving experienced EMR users. Qualitative research design using interviews and observations. Detailed information on participant selection, data collection and analysis. Two practices maintained a duplicate paper-based system which may have impacted their perceptions of the EMR system.

ABSTRACT: Background: Although primary care physicians are increasingly interested in adopting electronic medical record (EMR) systems, few use such systems in practice. This study explores the organizational impact of an EMR system on community-based practices that have overcome the initial barriers and are experienced EMR users. Methods: Five primary care practices that are members of a national research network participated in this study. Using qualitative methods, including semi-structured interviews and observations, we assessed the impact of an EMR system on the work lives of various user groups. Results: Physicians and staff indicated that the EMR system has changed not only how they manage patient records but also how they communicate with each other, provide patient care services, and perform job responsibilities. The EMR is also perceived by its users to have an impact on practice costs. Although in most practices physicians and staff were unaware of actual expenses and cost savings associated with the EMR, those in practices that have eliminated duplicate paper-based systems believe they have realized cost savings. Conclusions: Several important themes emerged. The organizational context in which the system is implemented is important. Effective leadership, the presence of a system champion, availability of technical training and support, and adequate resources are essential elements to the success of the EMR.

Weir C, Lincoln MJ, Roscoe D, Turner C, Moreshead G. Dimensions associated with successful implementation of a hospital based integrated order entry system. Proc Annu Symp on Comput Appl Med Care 1994; 653-657.

Study of six VA hospitals to identify variables associated with successful adoption of an integrated order entry/results reporting system. Identifies facilitating factors and barriers to use in the development of instrumentation for more detailed evaluation. Facilitating factor dimensions include functionality, technical support, perception of potential benefits, good training and instruction, support by medical administration, adequate hardware and mandatory implementation. Barrier dimensions include computer phobic attitude of physicians, inadequate training, poor implementation strategies, system not user friendly, system too slow, interdepartmental conflict and lack of effective support. Detailed

information on participant selection and data analysis. Findings explicitly stated in tabular format.

ABSTRACT: Implementation of an integrated electronic medical record requires direct physician order entry. This application involves multi-level changes in the whole system of care, from physicians' attitudes to interdepartmental relations. This study reports the results of the first round of a modified Delphi, where a diverse group of individuals were asked to identify the most important facilitating and impeding factors associated with implementation of an order entry application. From a Q-sort of their responses, we identified 20 systemic, behavioral, and attitudinal dimensions perceived to be causal factors in successful implementation. We also explored how these dimensions may influence success by comparing successful with unsuccessful hospitals in terms of the frequency with which these dimensions were differently mentioned by respondents. We found that although available functionality was the most commonly mentioned factor by all participants, hardware availability, physician involvement, administration support, and medical administration involvement were more often mentioned by successful hospitals than by less successful hospitals. These results suggest that these factors were not present in the less successful hospitals. We also found that the frequency of responses within each category varied depending on the institutional role of the individuals responding. Those involved in support tended to see organizational variables as more important than those in clinical positions, whereas clinicians viewed administrative support and involvement of the chief as more important. These findings support the notion that the changes involved in instituting a physician order entry system are system wide and involve individual as well as organizational factors.

Weir CR. Linking information needs with evaluation: the role of task identification. Proc AMIA Symp 1998; 310-314.

An exploratory study to identify information tasks to use in the development of indicators for evaluation purposes. Study conducted in two phases, using qualitative and quantitative methods. Focuses on subjective users perspectives. Study limited to one Veterans Health Care primary care clinic. Sample includes physicians and support staff from a range of clinical areas. Preliminary findings presented only.

ABSTRACT: Action Identification Theory was used to explore user's subjective constructions of information tasks in a primary care setting. The first part of the study involved collecting clinician's descriptions of their information tasks. These items were collated and then rated by another larger group of clinicians. Results clearly identified 6 major information tasks, including communication, patient assessment, work monitoring, seeking science information, compliance with policies and procedures, and data integration. Results discussed in terms of implications for evaluation and assessing information needs in a clinical setting.

Weir CR, Hurdle JF, Felgar MA, Hoffman JM, Roth B, Nebeker JR. Direct text entry in electronic progress notes. An evaluation of input errors. Methods of Information in Medicine 2003; 42(1):61-67.

Examines the incidence of documentation errors in a computerized patient record system at a VA tertiary care medical centre. Identifies criteria for evaluation and approach to classifying documentation errors. No comparison to documentation errors in a paper-based system. Sample limited to one site.

ABSTRACT: Objectives**:** It is not uncommon that the introduction of a new technology fixes old problems while introducing new ones. The Veterans Administration recently implemented a comprehensive electronic medical record system (CPRS) to support provider order entry. Progress notes are entered directly by clinicians, primarily through keyboard input. Due to concerns that there may be significant, invisible disruptions to information flow, this study was conducted to formally examine the incidence and characteristics of input errors in the electronic patient record. Methods: Sixty patient charts were randomly selected from all 2,301 inpatient admissions during a 5-month period. A panel of clinicians with informatics backgrounds developed the review criteria. After establishing inter-rater reliability, two raters independently reviewed 1,891 notes for copying, copying errors, inconsistent text, inappropriate object insertion and signature issues. Results: Overall, 60% of patients reviewed had one or more input-related errors averaging 7.8 errors per patient. About 20% of notes showed evidence of copying, with an average of 1.01 errors per copied note. Copying another clinician's note and making changes had the highest risk of error. Templating resulted in large amounts of blank spaces. Overall, MDs make more errors than other clinicians even after controlling for the number of notes. Conclusions: Moving towards a more progressive model for the electronic medical record, where actions are recorded only once, history and physical information is encoded for use later, and note generation is organized around problems, would greatly minimize the potential for error.

Wolfe H. Cost-benefit of laboratory computer systems. Journal of Medical Systems 1986; 10(1):1-9.

A before-and-after comparison of manual laboratory operations with operations after implementation of a laboratory computer system, using quantitative and qualitative methods. Inpatient setting. System supports transmission of results to wards, clinics and satellite facilities. Identifies indicators for evaluation including number of tests repeated due to reporting delays, number of tests repeated due to lost test results, number of telephone calls to laboratory, number of transcription errors, turnaround time, impact on staff morale, impact on retrieval of information and clinician satisfaction with services. Few details regarding sample recruitment, data collection and analysis. Very little information pertaining to a cost-benefit analysis.

ABSTRACT: The benefits and costs of a computer laboratory information system have been evaluated in three military hospitals, using a pre- and post-implementation comparison of time spent by laboratory and medical staff on information-handling activities, turnaround time for laboratory results, and staff perceptions of performance. The evaluation indicates that the laboratory information system is very cost-effective. A major benefit is the reduction in nursing staff time required to obtain laboratory test status and results.

Appendix A
Quality Assessment Tool and Report on the Systematic Assessment of the Published Literature and Program Reports

Background

Building upon the work of Freidman and Wyatt (1997) around approaches to the evaluation of health information systems, a comprehensive quality assessment tool was developed to critically appraise articles across a range of criteria which were both objectivist and subjectivist in nature. Key considerations in developing the quality assessment tool included:

(1) Relevance: How useful are the findings with respect to the task at hand i.e. do they contribute something new to our understanding of evaluation approaches for complex health information systems?
(2) Rigor: Has a thorough and appropriate approach been applied to key research methods in the study?
(3) Credibility: Are the findings well presented and meaningful?

Sub-questions in each category are provided below, followed by a copy of the Quality Assessment Tool used to summarize the critical appraisal of the literature, and the findings of the systematic review.

Relevance

- How valuable is the research in terms of the purpose of our study (developing an evaluation framework to assess EHR initiatives in Canada?)
- Did the researcher discuss how the study contributes to existing knowledge (e.g. impact of the findings on current practice, policy, or relevant literature)?
- Did the researcher identify new areas where research is necessary?

Rigor

- Was the objective of the research study clearly identified/explained?
- Did the study ask a clearly focused question?
- Was the research design appropriate to address the aims of the research: did the researcher explain why they used a particular methodology?
- Was the recruitment strategy appropriate to the aims of the research? How were participants selected? What was the rationale for selecting the participant group? Was non-participation explained?
- Were the data collected in a way that addressed the research issue?
- Was the setting for data collection clearly explained and justified?
- Was the data collection methodology clearly explained?
- Were data collection methods modified at any point and if so, how?
- Was the relationship between the researcher(s) and participants clearly described?
- Did the researcher critically examine their own role, potential bias and influence during (1) the formulation of the research questions; and (2) data collection, including sample recruitment and choice of location.
- Have ethical issues been taken into consideration? Were there sufficient details provided on how the research was explained to participants? Did the research undergo ethical review?
- Was the data analysis sufficiently rigorous? Was there an in-depth description of the analysis process? To what extent was contradictory data taken into account? Was sufficient data provided to support the findings?

- Did the researcher explain how the data presented were selected from the original sample to demonstrate the analysis process?

Credibility

- Are the findings explicit?
- Are the findings discussed in relation to the original research questions?
- Is there adequate discussion of conclusions?

Quality Assessment Tool
Developed for the Systematic Assessment of the Published Literature and Program Reports

CRITERIA	Ref ID #	Ref ID #	Ref ID #
Relevance			
Relevant to our research question (yes/no/partially)			
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

RESULTS OF THE SYSTEMATIC APPRAISAL OF THE LITERATURE

CRITERIA	1	2	3
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** One organization, but outlines approach to evaluation and identifies indicators for evaluation; pre- and post-implementation design.	**Partially.** One organization, but outlines approach to evaluation; pre- and post-implementation design.	**Partially.** One organization, but details approach to evaluation.
Identifies areas for further research (yes/no)	**No**	**Yes**	**Yes**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**No.** Difficult to determine what system components being evaluated	**No**	**Yes**
Clear objectives (yes/no)	**No.** Not stated	**No**	**Yes**
Appropriate research design (yes/no)	**Yes**	**Yes**	**Yes**
Appropriate sample recruitment (yes/no)	**Yes**	**Yes**	Little detail
Appropriate data collection (yes/no)	No detail	No detail	No detail
Relationship between researcher and participants clearly described (yes/no/partially)	**No**	**No**	**No**
Ethical issues considered (yes/no/partially)	**No**	**No**	**Partially.** Anonymity considered.
Rigorous data analysis (yes/no)	**No**	**Partially.** Uses triangulation of data sources.	**Yes**
Credibility			
Findings explicitly stated (yes/no)	**Yes**	**Yes** but limited to preliminary results for post-implementation component.	**Yes**
Findings discussed in relation to original research question (yes/no)	**No**	**Yes**	**Yes**
Adequate discussion of conclusions (yes/no)	**No**	**Yes**	**Yes**

CRITERIA	4	5	6
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Telemedicine; voluntary participation in internet based telepathology network; evaluation approach not well described.	**Yes.** Geographically dispersed system.	**Yes.** Geographically dispersed system; directly related to article #5.
Identifies areas for further research (yes/no)	**N/A**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**No**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	**Yes**
Clear objectives (yes/no)		**Yes**	**Yes**
Appropriate research design (yes/no)		**Yes.** However, not all pre- and post- measures were comparable.	**Yes.** However, not all pre- and post- measures were comparable.
Appropriate sample recruitment (yes/no)		Not clearly stated. Excludes pharmacists.	Not clearly stated
Appropriate data collection (yes/no)		**Yes**	**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)		**No**	**No**
Ethical issues considered (yes/no/partially)		**Yes**	**No**
Rigorous data analysis (yes/no)		**No**	**No**
Credibility			
Findings explicitly stated (yes/no)		**Yes**	**Yes**
Findings discussed in relation to original research question (yes/no)		**Yes**	**Yes**
Adequate discussion of conclusions (yes/no)		**Yes**	**Yes**

CRITERIA	7	8	9
Relevance			
Relevant to our research question (yes/no/partially)	**Yes**	**Yes.** Pharmacy network; identifies indicators for evaluation.	**Partially.** Details indicators to include in evaluation.
Identifies areas for further research (yes/no)	**N/A**	**No**	**No**
Included in annotated bibliography (yes/no)	**No.** Abstract only; few details provided.	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	**No**
Clear objectives (yes/no)		**No**	**No**
Appropriate research design (yes/no)		**Yes.** Survey design but not pre- and post-assessment.	**Yes.** Pre-/post-implementation design.
Appropriate sample recruitment (yes/no)		**Yes**	Little detail on recruitment efforts.
Appropriate data collection (yes/no)		**Yes**	Little detail
Relationship between researcher and participants clearly described (yes/no/partially)		**No**	**No**
Ethical issues considered (yes/no/partially)		**No**	**No**
Rigorous data analysis (yes/no)		**No.** Data analysis not described.	**No.** Limited to descriptive statistics.
Credibility			
Findings explicitly stated (yes/no)		**Yes**	**Yes**
Findings discussed in relation to original research question (yes/no)		**Yes**	**No**
Adequate discussion of conclusions (yes/no)		**Yes**	**No**

CRITERIA	10	11	12
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Outlines evaluation framework for geographically dispersed system; discussion paper.	**Yes.** Outlines evaluation framework for geographically dispersed system; directly related to article #10.	**Partially.** Identifies indicators for evaluation.
Identifies areas for further research (yes/no)	**No**	**No**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	**Yes**
Clear objectives (yes/no)	**N/A**	**N/A**	**No**
Appropriate research design (yes/no)	**N/A**	**N/A**	**No.** Cross-sectional design; post-implementation only.
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**Yes**
Appropriate data collection (yes/no)	**N/A**	**N/A**	Little detail provided
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**No**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**No**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**Yes**
Credibility			
Findings explicitly stated (yes/no)	**N/A.** Findings presented in discussion format.	**N/A**	**Yes**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**Yes**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**No**

CRITERIA	13	14	15
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Outlines approach to evaluation.	**No.** Describes a computer simulation model associated with ADEs.	**Partially.** ADE focus but substantial documentation on measurement approach; single setting only.
Identifies areas for further research (yes/no)	**No**		**No**
Included in annotated bibliography (yes/no)	**Yes**		**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**No**		**Yes**
Clear objectives (yes/no)	**No**		**Yes**
Appropriate research design (yes/no)	**No.** post-implementation only.		**Yes.** Prospective time series analysis with 4 time periods.
Appropriate sample recruitment (yes/no)	No details provided.		**Yes**
Appropriate data collection (yes/no)	Few details provided.		**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)	**No**		**No**
Ethical issues considered (yes/no/partially)	**No**		**No**
Rigorous data analysis (yes/no)	**No**		**Yes**
Credibility			
Findings explicitly stated (yes/no)	**Yes**		**Yes**
Findings discussed in relation to original research question (yes/no)	**No.** Research question not stated.		**Yes**
Adequate discussion of conclusions (yes/no)	**No**		**Yes**

CRITERIA	16	17	18
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Single site, focuses on ADE; no additional evaluation information over and above reference #15.	**No.** Single site, ADE focus.	**No.** Telepharmacy; focuses on drug utilization review.
Identifies areas for further research (yes/no)	**Yes**		
Included in annotated bibliography (yes/no)	**No**		
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	19	20	21
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Physician perceptions of on-site POE system.	**No.** One site, one discipline focus.	**Yes.** Comparison of paper and electronic systems; identification of evaluation indicators.
Identifies areas for further research (yes/no)			**Yes**
Included in annotated bibliography (yes/no)			**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)			**Yes**
Clear objectives (yes/no)			**Yes**
Appropriate research design (yes/no)			**Yes**
Appropriate sample recruitment (yes/no)			**Yes**
Appropriate data collection (yes/no)			**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)			**Partially**
Ethical issues considered (yes/no/partially)			**No**
Rigorous data analysis (yes/no)			**Yes**
Credibility			
Findings explicitly stated (yes/no)			**Yes**
Findings discussed in relation to original research question (yes/no)			**Yes**
Adequate discussion of conclusions (yes/no)			**Yes**

CRITERIA	22	23	24
Relevance			
Relevant to our research question (yes/no/partially)	**No**. Limited to single setting; weak study design.	**Partially.** Single site but identifies indicators for evaluation.	**Partially.** Single site lab system evaluation; limited new information on evaluation design.
Identifies areas for further research (yes/no)		**No**	**No**
Included in annotated bibliography (yes/no)		**Yes**	**No**
Rigor			
Purpose/goal clearly stated (yes/no)		**No**	
Clear objectives (yes/no)		**No**	
Appropriate research design (yes/no)		**No.** Very little information pertaining to cost-benefit analysis.	
Appropriate sample recruitment (yes/no)		Little detail	
Appropriate data collection (yes/no)		**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)		**Partially**	
Ethical issues considered (yes/no/partially)		**No**	
Rigorous data analysis (yes/no)		**No.** Little data regarding cost-benefit analysis.	
Credibility			
Findings explicitly stated (yes/no)		**Yes**	
Findings discussed in relation to original research question (yes/no)		**No.** Little information pertaining to cost-benefit.	
Adequate discussion of conclusions (yes/no)		**No**	

CRITERIA	25	26	27
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Focuses on user satisfaction using qualitative methods.	**No.** Focuses on social and cognitive impact of allowing patients to have access to their health record via web.	**No.** Focuses on physicians expectations in one hospital system.
Identifies areas for further research (yes/no)	**No**		
Included in annotated bibliography (yes/no)	**Yes**		
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**		
Clear objectives (yes/no)	**Yes**		
Appropriate research design (yes/no)	**Yes**		
Appropriate sample recruitment (yes/no)	**Yes**		
Appropriate data collection (yes/no)	**Yes**		
Relationship between researcher and participants clearly described (yes/no/partially)	**No**		
Ethical issues considered (yes/no/partially)	**No**		
Rigorous data analysis (yes/no)	**Yes.** But limited with regard to feedback to participants.		
Credibility			
Findings explicitly stated (yes/no)	**Yes**		
Findings discussed in relation to original research question (yes/no)	**Yes**		
Adequate discussion of conclusions (yes/no)	**Yes**		

CRITERIA	28	29	30
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Focuses on evaluation frameworks for health system performance.	**No.** No focus on evaluation; discussion of system design issues.	**Yes.** Discussion of evaluation approaches in information systems.
Identifies areas for further research (yes/no)	**Yes**		**No**
Included in annotated bibliography (yes/no)	**Yes**		**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.		**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**		**N/A**
Appropriate research design (yes/no)	**N/A**		**N/A**
Appropriate sample recruitment (yes/no)	**N/A**		**N/A**
Appropriate data collection (yes/no)	**N/A**		**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		**N/A**
Ethical issues considered (yes/no/partially)	**N/A**		**N/A**
Rigorous data analysis (yes/no)	**N/A**		**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**		**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**		**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**		**N/A**

CRITERIA	31	32	33
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Discussion of issues concerning evaluation of health information systems.	**Partially.** Classifies evaluation studies of automated information systems in health care; not specific to EHR systems.	**Yes.** Discusses approaches to evaluating health information systems. (1992 article)
Identifies areas for further research (yes/no)	**No**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**Yes**	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**Yes**	**N/A**
Appropriate research design (yes/no)	**N/A**	**Yes**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**Yes.** But 10% of studies detected not reviewed as they were not available in Dutch libraries.	**N/A**
Appropriate data collection (yes/no)	**N/A**	**Yes**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**No**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	Not described.	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**Yes**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**Yes**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**Yes**	**N/A**

CRITERIA	34	35	36
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Overview of approaches to evaluating user satisfaction.	**Yes.** Describes a large scale health care information system evaluation project, but does not report project results.	**Yes.** Identifies an evaluation model for clinical imaging systems. Abstract only.
Identifies areas for further research (yes/no)	**No**	**N/A**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**No.** Abstract only; few details provided.
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	
Clear objectives (yes/no)	**N/A**	**N/A**	
Appropriate research design (yes/no)	**N/A**	**N/A**	
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	
Appropriate data collection (yes/no)	**N/A**	**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	
Rigorous data analysis (yes/no)	**N/A**	**N/A**	
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	

CRITERIA	37	38	39
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Discussion piece around evaluation criteria for district health information systems in South Africa.	**No.** Single hospital focus; not a complete research report.	**No.** Focuses on clinical practice guidelines.
Identifies areas for further research (yes/no)	**Yes**		
Included in annotated bibliography (yes/no)	**Yes**		
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.		
Clear objectives (yes/no)	**N/A**		
Appropriate research design (yes/no)	**N/A**		
Appropriate sample recruitment (yes/no)	**N/A**		
Appropriate data collection (yes/no)	**N/A**		
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		
Ethical issues considered (yes/no/partially)	**N/A**		
Rigorous data analysis (yes/no)	**N/A**		
Credibility			
Findings explicitly stated (yes/no)	**N/A**		
Findings discussed in relation to original research question (yes/no)	**N/A**		
Adequate discussion of conclusions (yes/no)	**N/A**		

CRITERIA	40	41	42
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Outlines approaches to evaluating medical information systems.	**Yes.** Identification of success indicators for an evaluation framework.	**Yes.** Study of patient attitudes towards computerized medical records.
Identifies areas for further research (yes/no)	**No**	**No**	**Yes**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as a research article.	**N/A.** Not assessed as a research article.	**Yes**
Clear objectives (yes/no)	**N/A**	**N/A**	**Yes**
Appropriate research design (yes/no)	**N/A**	**N/A**	**Yes.** Survey design.
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**Yes.** But limited to one practice area with relatively small sample size.
Appropriate data collection (yes/no)	**N/A**	**N/A**	**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**No**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**No**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**No**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	**Yes**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**Yes**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**Yes**

CRITERIA	43	44	45
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on cognitive evaluation of decision making processes.	**Partially.** Indicators of quality in the EMR identified.	**No.** Focuses on home-based computer personal support system.
Identifies areas for further research (yes/no)		**No**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	
Clear objectives (yes/no)		**Yes**	
Appropriate research design (yes/no)		**Yes.** But cross sectional study limited to descriptive findings.	
Appropriate sample recruitment (yes/no)		**Yes**	
Appropriate data collection (yes/no)		**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)		**No**	
Ethical issues considered (yes/no/partially)		**Partially.** Anonymity of patient records.	
Rigorous data analysis (yes/no)		**Yes**	
Credibility			
Findings explicitly stated (yes/no)		**Yes**	
Findings discussed in relation to original research question (yes/no)		**Yes**	
Adequate discussion of conclusions (yes/no)		**Yes**	

CRITERIA	46	47	48
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on cognitive evaluation techniques.	**No.** Focuses on development and usability of one type of programming within a system.	**Yes.** Identifies criteria for evaluation and approach to classifying documentation errors in EHR systems.
Identifies areas for further research (yes/no)			**Yes**
Included in annotated bibliography (yes/no)			**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)			**Yes**
Clear objectives (yes/no)			**No**
Appropriate research design (yes/no)			**Yes**
Appropriate sample recruitment (yes/no)			**Yes.** But limited to one site and small sample size.
Appropriate data collection (yes/no)			**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)			**No**
Ethical issues considered (yes/no/partially)			**No**
Rigorous data analysis (yes/no)			**Yes**
Credibility			
Findings explicitly stated (yes/no)			**Yes**
Findings discussed in relation to original research question (yes/no)			**Yes**
Adequate discussion of conclusions (yes/no)			**Yes**

CRITERIA	49	50	51
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Technology/system design focus.	**Yes**. Identifies indicators for measuring impact on resources, but limited to PACS evaluation in one setting.	**No.** Pre-implementation observation report of filmless radiology pilot.
Identifies areas for further research (yes/no)		**No**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	
Clear objectives (yes/no)		**No**	
Appropriate research design (yes/no)		**Yes.** Pre-/post-implementation design.	
Appropriate sample recruitment (yes/no)		**Yes**	
Appropriate data collection (yes/no)		**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)		**No**	
Ethical issues considered (yes/no/partially)		**No**	
Rigorous data analysis (yes/no)		**Yes**	
Credibility			
Findings explicitly stated (yes/no)		**Yes**	
Findings discussed in relation to original research question (yes/no)		**Yes**	
Adequate discussion of conclusions (yes/no)		**Yes**	

CRITERIA	52	53	54
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Technology/workflow focus.	**Yes.** Evaluation approach focusing on the imaging system of the VA EHR.	**Yes.** Approach to evaluating physician order entry with EHRs.
Identifies areas for further research (yes/no)		**Yes**	**Yes**
Included in annotated bibliography (yes/no)		**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	**Yes**
Clear objectives (yes/no)		**No**	**No.** Not stated
Appropriate research design (yes/no)		**Yes**	**Yes.** With limitations were reported by the authors.
Appropriate sample recruitment (yes/no)		**Yes**	**Yes**
Appropriate data collection (yes/no)		**Yes**	**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)		**Yes**	**No**
Ethical issues considered (yes/no/partially)		**No**	**Yes.** Surveys were anonymous and study was approved by Institutional Review Board.
Rigorous data analysis (yes/no)		**Yes**	**Yes**
Credibility			
Findings explicitly stated (yes/no)		**Yes**	**Yes**
Findings discussed in relation to original research question (yes/no)		**Yes**	**Yes**
Adequate discussion of conclusions (yes/no)		**Yes**	**Yes**

CRITERIA	55	56	57
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Review of the use of computers in primary care.	**Yes.** Review of evaluation paradigms in health informatics.	**Yes.** Outlines assessment framework for health information systems.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**	**N/A.** Not assessed as a research article.	**N/A**
Clear objectives (yes/no)	**Yes**	**N/A**	**N/A**
Appropriate research design (yes/no)	**Yes**	**N/A**	**N/A**
Appropriate sample recruitment (yes/no)	**Yes.** But not clear how articles for review were reduced from 1892 to 214.	**N/A**	**N/A**
Appropriate data collection (yes/no)	**Yes**	**N/A**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**No**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**No**	**N/A**	**N/A**
Rigorous data analysis (yes/no)	**Yes**	**N/A**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**Yes**	**N/A**	**N/A**
Findings discussed in relation to original research question (yes/no)	**Yes**	**N/A**	**N/A**
Adequate discussion of conclusions (yes/no)	**Yes**	**N/A**	**N/A**

CRITERIA	58	59	60
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Based on pilot pharmacy system with 17 physicians; focus on decision support issues.	**Yes.** Discussion of evaluation approaches in health informatics.	**No.** Focuses on EMR impact on cognitive processes involved in MD-patient communication.
Identifies areas for further research (yes/no)		**Yes**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**N/A.** Not assessed as research article.	
Clear objectives (yes/no)		**N/A**	
Appropriate research design (yes/no)		**N/A**	
Appropriate sample recruitment (yes/no)		**N/A**	
Appropriate data collection (yes/no)		**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)		**N/A**	
Ethical issues considered (yes/no/partially)		**N/A**	
Rigorous data analysis (yes/no)		**N/A**	
Credibility			
Findings explicitly stated (yes/no)		**N/A**	
Findings discussed in relation to original research question (yes/no)		**N/A**	
Adequate discussion of conclusions (yes/no)		**N/A**	

CRITERIA	61	62	63
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Exploratory study to identify information tasks for use in health information system evaluation; one site.	**Partially.** Focuses on implementation projects in Canada with some discussion of evaluation components.	**No.** Focuses on computer simulation.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**	**Yes**	
Clear objectives (yes/no)	**No.** Not stated	**Yes**	
Appropriate research design (yes/no)	**Yes**	**Yes**	
Appropriate sample recruitment (yes/no)	**Yes.** But small numbers.	**Yes.** Limitations identified by authors.	
Appropriate data collection (yes/no)	**Yes**	**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)	**No**	**No**	
Ethical issues considered (yes/no/partially)	**No**	**No**	
Rigorous data analysis (yes/no)	**Yes.** But preliminary and exploratory.	Not well described.	
Credibility			
Findings explicitly stated (yes/no)	**Yes**	**Yes**	
Findings discussed in relation to original research question (yes/no)	**Yes**	**Yes**	
Adequate discussion of conclusions (yes/no)	**Yes**	**Yes**	

CRITERIA	64	65	66
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Describes a framework for distance evaluation of web-based health information technologies.	**No.** Description of privacy protection measures; no evaluation component.	**Yes.** Discussion paper on global evaluation methods for health information systems.
Identifies areas for further research (yes/no)	**Yes**		**No**
Included in annotated bibliography (yes/no)	**Yes**		**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A** not assessed as research article.		**N/A** not assessed as research article.
Clear objectives (yes/no)	**N/A**		**N/A**
Appropriate research design (yes/no)	**N/A**		**N/A**
Appropriate sample recruitment (yes/no)	**N/A**		**N/A**
Appropriate data collection (yes/no)	**N/A**		**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		**N/A**
Ethical issues considered (yes/no/partially)	**N/A**		**N/A**
Rigorous data analysis (yes/no)	**N/A**		**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**		**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**		**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**		**N/A**

CRITERIA	67	68	69
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Outlines evaluation framework approach in the Netherlands.	**Yes.** Discussion on how to use EMRs to evaluate health care interventions.	**No.** Focuses on human cognition.
Identifies areas for further research (yes/no)	**No**	**No**	
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	
Clear objectives (yes/no)	**N/A**	**N/A**	
Appropriate research design (yes/no)	**N/A**	**N/A**	
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	
Appropriate data collection (yes/no)	**N/A**	**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	
Rigorous data analysis (yes/no)	**N/A**	**N/A**	
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	

CRITERIA	70	71	72
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Focuses on approach to usability testing.	**Yes.** Evaluation approach for the NHS information system.	**Yes.** Discussion of a framework for including usability engineering approaches in HIS evaluation.
Identifies areas for further research (yes/no)	**Yes**	**No**	**Yes**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate research design (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**N/A**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**N/A**

CRITERIA	73	74	75
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Discussion paper; focuses on HIS impact on ability to measure and improve quality.	**Yes.** Demonstrates impact of an electronic database on capacity to do research.	**No.** Highly technical evaluation of human-computer interface.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**Yes**	
Clear objectives (yes/no)	**N/A**	**Yes**	
Appropriate research design (yes/no)	**N/A**	**Yes**	
Appropriate sample recruitment (yes/no)	**N/A**	**Yes**	
Appropriate data collection (yes/no)	**N/A**	**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**No**	
Ethical issues considered (yes/no/partially)	**N/A**	**Yes.** Received ethical approval and authorized access to prescription records.	
Rigorous data analysis (yes/no)	**N/A**	**Yes**	
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**Yes**	
Findings discussed in relation to original research question (yes/no)	**N/A**	**Yes**	
Adequate discussion of conclusions (yes/no)	**N/A**	**Yes**	

CRITERIA	76	77	78
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Simulation studies; highly technical in focus.	**Yes.** Outlines the role of experts in system performance evaluation.	**No.** Single site, single discipline software implementation, not linked to the hospital HIS.
Identifies areas for further research (yes/no)		**Yes**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**N/A.** Not assessed as research article.	
Clear objectives (yes/no)		**N/A**	
Appropriate research design (yes/no)		**N/A**	
Appropriate sample recruitment (yes/no)		**N/A**	
Appropriate data collection (yes/no)		**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)		**N/A**	
Ethical issues considered (yes/no/partially)		**N/A**	
Rigorous data analysis (yes/no)		**N/A**	
Credibility			
Findings explicitly stated (yes/no)		**N/A**	
Findings discussed in relation to original research question (yes/no)		**N/A**	
Adequate discussion of conclusions (yes/no)		**N/A**	

CRITERIA	79	80	81
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focus on one site implementation of a combined educational program and automated physician reminders.	**No.** Focuses on home-based computer personal support system.	**No.** Focuses on patient utilization of web-based information; report of pilot study involving 8 subjects.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	82	83	84
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on paper based medical records.	**No.** Focuses on single site implementation of computerized physician reminders.	**No.** Pilot study of a system prototype involving 4 physicians focusing on interface design.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	85	86	87
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Commentary on when to use experts in systems evaluation (references #77).	**No.** Description of system implementation only; no evaluation component.	**No.** Cognitive focus on user interface in one outpatient information system involving 9 participants.
Identifies areas for further research (yes/no)	**No**		
Included in annotated bibliography (yes/no)	**Yes**		
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.		
Clear objectives (yes/no)	**N/A**		
Appropriate research design (yes/no)	**N/A**		
Appropriate sample recruitment (yes/no)	**N/A**		
Appropriate data collection (yes/no)	**N/A**		
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		
Ethical issues considered (yes/no/partially)	**N/A**		
Rigorous data analysis (yes/no)	**N/A**		
Credibility			
Findings explicitly stated (yes/no)	**N/A**		
Findings discussed in relation to original research question (yes/no)	**N/A**		
Adequate discussion of conclusions (yes/no)	**N/A**		

CRITERIA	88	89	90
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Discussion piece focusing on the history of the internet and its relationship to medical informatics and the US health care system.	**Partially.** Excellent overview of lab network development but no evaluation component.	**No.** Focus on information design principles; no evaluation component.
Identifies areas for further research (yes/no)		**No**	
Included in annotated bibliography (yes/no)		**No**	
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	91	92	93
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Systematic review of data quality in electronic patient records in primary care.	**Yes.** General commentary on EHRs.	**Partially.** Discussion of factors influencing the development of an EHR; good overview of HIN requirements.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**No**
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**	**N/A.** Not assessed as research article.	
Clear objectives (yes/no)	**No.** Not stated	**N/A**	
Appropriate research design (yes/no)	**Yes**	**N/A**	
Appropriate sample recruitment (yes/no)	**Yes**	**N/A**	
Appropriate data collection (yes/no)	**Yes**	**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	
Rigorous data analysis (yes/no)	**Yes**	**N/A**	
Credibility			
Findings explicitly stated (yes/no)	**Yes**	**N/A**	
Findings discussed in relation to original research question (yes/no)	**Yes**	**N/A**	
Adequate discussion of conclusions (yes/no)	**Yes**	**N/A**	

CRITERIA	94	95	96
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Describes evolution of an integrated HIS in Netherlands including evaluation needs.	**Partially.** Overview of HIN development in Canada and role of standards; no evaluation component.	**Partially.** Discussion of research agenda for health informatics.
Identifies areas for further research (yes/no)	**No**	**N/A**	**Yes**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate research design (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**N/A**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**N/A**

CRITERIA	97	98	99
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Overview of EHR introduction in Kaiser Permanente Northwest; little focus on evaluation.	**Partially.** Addresses ethics of health sector databases using Iceland's experience; indicators for privacy impact can be derived from discussion.	**Partially.** Overview of CIHI and Infoway activities as of June 2002.
Identifies areas for further research (yes/no)		**Yes**	**No**
Included in annotated bibliography (yes/no)		**Yes**	**No**
Rigor			
Purpose/goal clearly stated (yes/no)		**N/A.** Not assessed as research article.	
Clear objectives (yes/no)		**N/A**	
Appropriate research design (yes/no)		**N/A**	
Appropriate sample recruitment (yes/no)		**N/A**	
Appropriate data collection (yes/no)		**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)		**N/A**	
Ethical issues considered (yes/no/partially)		**N/A**	
Rigorous data analysis (yes/no)		**N/A**	
Credibility			
Findings explicitly stated (yes/no)		**N/A**	
Findings discussed in relation to original research question (yes/no)		**N/A**	
Adequate discussion of conclusions (yes/no)		**N/A**	

CRITERIA	100	101	102
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Case study of an integrated healthcare delivery network in Virginia; no evaluation data provided.	**Yes.** Discusses failure of EMR project linking hospitals and other agencies in South Central New York.	**Partially.** Outlines methods for measuring validity and utility of electronic patient records in general practice.
Identifies areas for further research (yes/no)		**No**	**No**
Included in annotated bibliography (yes/no)		**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)		**N/A.** Not assessed as research article.	**Yes**
Clear objectives (yes/no)		**N/A**	**Partially.** Two stages of the study described.
Appropriate research design (yes/no)		**N/A**	**Yes**
Appropriate sample recruitment (yes/no)		**N/A**	**Yes.** But study period in stage 1 limited to 1 week.
Appropriate data collection (yes/no)		**N/A**	**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)		**N/A**	**No**
Ethical issues considered (yes/no/partially)		**N/A**	**Partially.** Approval by ethics committee.
Rigorous data analysis (yes/no)		**N/A**	**Yes**
Credibility			
Findings explicitly stated (yes/no)		**N/A**	**Yes**
Findings discussed in relation to original research question (yes/no)		**N/A**	**Yes**
Adequate discussion of conclusions (yes/no)		**N/A**	**No**

CRITERIA	103	104	105
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Discussion piece around success factors for EHRs.	**Partially.** Brief discussion piece around principles underling EHR development.	**No.** Cognitive, sociocultural & logistical issues encountered when diverse backgrounds use communications technologies.
Identifies areas for further research (yes/no)	**No**	**No**	
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	
Clear objectives (yes/no)	**N/A**	**N/A**	
Appropriate research design (yes/no)	**N/A**	**N/A**	
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	
Appropriate data collection (yes/no)	**N/A**	**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	
Rigorous data analysis (yes/no)	**N/A**	**N/A**	
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	

CRITERIA	106	107	108
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Includes a discussion of evaluation criteria and test methods applied to computerized provider order entry systems.	**Yes.** Discusses criteria for evaluating EMR systems from the perspective of a family physician.	**Yes.** Outlines pre-implementation evaluation plan in acute care clinical settings; focuses on pre-implementation documentation.
Identifies areas for further research (yes/no)	**No**	**No**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate research design (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**N/A**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**N/A**

CRITERIA	109	110	111
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Relevant commentary on evaluation.	**Yes.** Evaluation of a computerized nursing information system using time series design; one site but strong methodology.	**Yes.** Discusses challenges associated with information technology evaluation.
Identifies areas for further research (yes/no)	**No**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**Yes**	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**No**	**N/A**
Appropriate research design (yes/no)	**N/A**	**Yes**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**Yes**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**Yes**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**Yes**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**Partially.** Obtained Institutional Review Board and site approval.	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**Yes**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**Yes**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**Yes**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**Yes**	**N/A**

CRITERIA	112	113	114
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Discussion piece including use of SWOT method of analysis.	**No.** System design focus; no evaluation component.	**Yes.** Literature review focusing on costs and benefits of computers in the NHS; not limited to EHR systems.
Identifies areas for further research (yes/no)	**No**		**Yes**
Included in annotated bibliography (yes/no)	**Yes**		**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.		**No**
Clear objectives (yes/no)	**N/A**		**No**
Appropriate research design (yes/no)	**N/A**		**Yes**
Appropriate sample recruitment (yes/no)	**N/A**		**Yes**
Appropriate data collection (yes/no)	**N/A**		Few details provided.
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		**Yes.** Conflict of interest declared.
Ethical issues considered (yes/no/partially)	**N/A**		**No**
Rigorous data analysis (yes/no)	**N/A**		**Yes**
Credibility			
Findings explicitly stated (yes/no)	**N/A**		**Yes.** But little information presented regarding benefits of hospital information systems.
Findings discussed in relation to original research question (yes/no)	**N/A**		Research question not clear.
Adequate discussion of conclusions (yes/no)	**N/A**		**No**

CRITERIA	115	116	117
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Discussion piece on the role of evaluation in information system development.	**Yes.** A summary discussion piece on the evolution of health information systems since 1994.	**Yes** Discusses different terminology used to describes HIS development.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate research design (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**N/A**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**N/A**

CRITERIA	118	119	120
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Addresses the role of practice guidelines in electronic health record systems.	**Partially.** Identifies cost variables related to electronic order entry systems; single site.	**No.** Focuses on role of computers in mediating physician behavior change.
Identifies areas for further research (yes/no)		**Yes**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	
Clear objectives (yes/no)		**No**	
Appropriate research design (yes/no)		Few details provided.	
Appropriate sample recruitment (yes/no)		Few details provided.	
Appropriate data collection (yes/no)		Few details provided.	
Relationship between researcher and participants clearly described (yes/no/partially)		**No**	
Ethical issues considered (yes/no/partially)		**No**	
Rigorous data analysis (yes/no)		Analysis based on theoretical system implementation, synthesis of literature & estimates by vendors.	
Credibility			
Findings explicitly stated (yes/no)		Not always clear how costs and potential savings were determined.	
Findings discussed in relation to original research question (yes/no)		**Yes**	
Adequate discussion of conclusions (yes/no)		**No**	

CRITERIA	121	122	123
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Discussion document; overview of contribution of information technology to patient safety.	**Partially.** Assesses the impact of an EMR on 5 community-based primary care practices; uses qualitative methods.	**No.** Outside project scope; focus on discussion of potential interface between public health and EHRs.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**Yes**	
Clear objectives (yes/no)		**No**. Not stated.	
Appropriate research design (yes/no)		**Yes**	
Appropriate sample recruitment (yes/no)		**Yes**	
Appropriate data collection (yes/no)		**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)		**Yes**	
Ethical issues considered (yes/no/partially)		**Partially.** Key informants were insured confidentiality of responses.	
Rigorous data analysis (yes/no)		**Yes**	
Credibility			
Findings explicitly stated (yes/no)		**Yes**	
Findings discussed in relation to original research question (yes/no)		**Yes**	
Adequate discussion of conclusions (yes/no)		**Yes**	

CRITERIA	124	125	126
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Overview of vendor specific product offerings.	**No.** Survey of vendors involved in computerized patient record systems.	**No.** Focus on clinical decision support in a small psychiatric setting.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	127	128	129
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on system functionality of a master patient index.	**No.** Describes implementation experience of a master patient index in the Boston area; no evaluation component.	**No.** Focuses on process of developing a master patient index; no evaluation component.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	130	131	132
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on system development issues.	**No.** Focuses on one hospital communications system; case study report; summary information provided only.	**No.** Focuses on a framework for problem oriented medical records.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	133	134	135
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Vendor survey.	**No.** Focuses on palmtops; outside project scope.	**No.** Implementation focus; no evaluation data.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	136	137	138
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Description of architecture framework.	**No.** Focuses on problem-oriented patient records.	**No.** Technical focus on system architecture.
Identifies areas for further research (yes/no)		**No**	
Included in annotated bibliography (yes/no)		**No**	
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	139	140	141
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Case study of CPR implementation at one site; no evaluation data.	**No.** Outside project scope; focuses on web applications.	**Yes.** Discussion document addressing the problems with EMRs in a variety of settings, including the ICU.
Identifies areas for further research (yes/no)			**No**
Included in annotated bibliography (yes/no)			**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)			**N/A.** Not assessed as research article.
Clear objectives (yes/no)			**N/A**
Appropriate research design (yes/no)			**N/A**
Appropriate sample recruitment (yes/no)			**N/A**
Appropriate data collection (yes/no)			**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)			**N/A**
Ethical issues considered (yes/no/partially)			**N/A**
Rigorous data analysis (yes/no)			**N/A**
Credibility			
Findings explicitly stated (yes/no)			**N/A**
Findings discussed in relation to original research question (yes/no)			**N/A**
Adequate discussion of conclusions (yes/no)			**N/A**

CRITERIA	142	143	144
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on clinical practice guidelines.	**No.** General discussion piece on the electronic environment.	**No.** Focuses on research capacity and the world wide web.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	145	146	147
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on implementation at a single site.	**No.** Offers advice for system purchasing.	**No.** Decision support with focus on cost of drugs.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	148	149	150
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Editorial discussion only.	**No.** Focus on quality improvement and utilization of practice guidelines.	**No.** Outside project scope; focuses on alphanumeric pagers for real-time notification of lab data.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	151	152	153
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Pre- and post analysis of the impact of an EMR on the quality of care at an urban pediatric primary care centre.	**No.** Editorial comment.	**No.** Focuses on change management strategies during system implementation.
Identifies areas for further research (yes/no)	**No**		
Included in annotated bibliography (yes/no)	**Yes**		
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**		
Clear objectives (yes/no)	**Yes**		
Appropriate research design (yes/no)	**Yes.** Pre- and post-implementation design.		
Appropriate sample recruitment (yes/no)	**Yes.** But pre-implementation sample smaller than post-implementation sample.		
Appropriate data collection (yes/no)	**Yes**		
Relationship between researcher and participants clearly described (yes/no/partially)	**Partially**		
Ethical issues considered (yes/no/partially)	**Partially.** Approved by Review Board.		
Rigorous data analysis (yes/no)	**Yes**		
Credibility			
Findings explicitly stated (yes/no)	**Yes**		
Findings discussed in relation to original research question (yes/no)	**Yes**		
Adequate discussion of conclusions (yes/no)	**Yes**		

CRITERIA	154	155	156
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Focus is on impatient clinical information systems, but includes extensive data on evaluation.	**No.** Focuses on technical architecture.	**Yes.** Identifies critical success factors for CPR systems including steps to evaluate such systems.
Identifies areas for further research (yes/no)	**Yes**		**No**
Included in annotated bibliography (yes/no)	**Yes**		**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**		**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**Yes**		**N/A**
Appropriate research design (yes/no)	**Yes**		**N/A**
Appropriate sample recruitment (yes/no)	**Yes**		**N/A**
Appropriate data collection (yes/no)	**Yes.** But Bibliographies of selected articles not searched for additional relevant literature.		**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		**N/A**
Ethical issues considered (yes/no/partially)	**No**		**N/A**
Rigorous data analysis (yes/no)	**Yes**		**N/A**
Credibility			
Findings explicitly stated (yes/no)	**Yes**		**N/A**
Findings discussed in relation to original research question (yes/no)	**Yes**		**N/A**
Adequate discussion of conclusions (yes/no)	**Yes**		**N/A**

CRITERIA	157	158	159
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on computer based clinical guidelines.	**Partially.** Literature review of effectiveness of EHRs as tools for improving surrogate patient outcomes in primary care setting.	**Yes.** Survey of clinician users of a CPR system; identifies indicators for evaluation.
Identifies areas for further research (yes/no)		**Yes**	**No**
Included in annotated bibliography (yes/no)		**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	**Yes**
Clear objectives (yes/no)		**No.** Not stated	**No.** Not stated
Appropriate research design (yes/no)		**Yes**	Survey appropriate, but post-implementation study only.
Appropriate sample recruitment (yes/no)		**Yes**	A single individual completed survey on behalf of entire practice.
Appropriate data collection (yes/no)		**Yes**	**Yes**
Relationship between researcher and participants clearly described (yes/no/partially)		**N/A**	**No**
Ethical issues considered (yes/no/partially)		**N/A**	**No**
Rigorous data analysis (yes/no)		**Yes**	Descriptive data only
Credibility			
Findings explicitly stated (yes/no)		**Yes**	**Yes**
Findings discussed in relation to original research question (yes/no)		**Yes.** Discussed in relation to revised research question.	**Yes**
Adequate discussion of conclusions (yes/no)		**Yes**	**Yes**

CRITERIA	160	161	162
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Outside project scope; consumer internet information sources.	**Yes.** Update on CPR development in United States.	**No.** Commentary on Kaiser Permanente's use of EMRs.
Identifies areas for further research (yes/no)		**No**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**N/A.** Not assessed as research article.	
Clear objectives (yes/no)		**N/A**	
Appropriate research design (yes/no)		**N/A**	
Appropriate sample recruitment (yes/no)		**N/A**	
Appropriate data collection (yes/no)		**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)		**N/A**	
Ethical issues considered (yes/no/partially)		**N/A**	
Rigorous data analysis (yes/no)		**N/A**	
Credibility			
Findings explicitly stated (yes/no)		**N/A**	
Findings discussed in relation to original research question (yes/no)		**N/A**	
Adequate discussion of conclusions (yes/no)		**N/A**	

CRITERIA	163	164	165
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on design implementation of a single disease management system.	**No.** Description of system implementation; no evaluation component.	**No.** editorial commentary only.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	166	167	168
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Evaluation framework for the NHS; provides comprehensive review of methodologies that may be applied to the evaluation of EHRs.	**Yes.** Evaluation report on HIS being implemented across Northern Province of South Africa; detailed methodology.	**Yes.** Provides practical support for those involved in evaluation of EHRs and other information systems projects. (handbook to #166).
Identifies areas for further research (yes/no)	**N/A**	**Yes**	**N/A**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**Yes**	**N/A.** Not assessed as research article.
Clear objectives (yes/no)	**N/A**	**Yes**	**N/A**
Appropriate research design (yes/no)	**N/A**	**Yes.** Changed from RCT to pre-/post-implementation study.	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**Yes**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**Yes**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**No**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**No**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**Yes**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**Yes**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**Yes**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**Yes**	**N/A**

CRITERIA	169	170	171
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** NHS information authority update on the Electronic Record Development and Implementation program.	**Yes.** Medical Records Institute 5th annual survey of EHR trends and usage.	**No.** Discussion piece focusing on implications of liking pharmacy and laboratory data.
Identifies areas for further research (yes/no)	**N/A**	**N/A**	
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Summary results only. Full survey $250; unable to critique methods.	
Clear objectives (yes/no)	**N/A**	**N/A**	
Appropriate research design (yes/no)	**N/A**	**N/A**	
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	
Appropriate data collection (yes/no)	**N/A**	**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	
Rigorous data analysis (yes/no)	**N/A**	**N/A**	
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	

CRITERIA	172	173	174
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on registration guidelines for maintenance of an enterprise patient master index in South Australia.	**No.** Focuses on the implementation of an enterprise master patient index at Health Alliance of Greater Cincinnati; no evaluation component.	**No.** Discussion piece on the impact of computerized prescribing.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	175	176	177
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Discussion piece focusing on barriers to computerization in primary care.	**No.** A comparison of two types of enterprise master patient index vendors.	**No.** Discussion piece focusing on information technology advances in the clinical laboratory.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	178	179	180
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Discussion piece on the features of a clinical information system that are necessary for improved patient care.	**No.** Discusses upcoming implementation of a Clinical Information and Communications System & Data Repository, Northern Territory of Australia.	**No.** Discussion piece on the evolution of medical records with a focus on web-based technologies.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	181	182	183
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Commentary on electronic medical records.	**No.** Describes the transformation of a paper to electronic system for admission assessment in the VA system; no evaluation data provided.	**No.** Describes the computerized patient record system (CPRS) in the Department of Veterans Affairs; technology focus.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	184	185	186
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Discussion piece focusing on the evaluation of non-technological issues in medical informatics (directly related to article #40).	**No.** Describes approach to information resources assessment associated with a client-server architecture transition in the VA system.	**No.** Technology focus.
Identifies areas for further research (yes/no)	**No**		
Included in annotated bibliography (yes/no)	**Yes**		
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.		
Clear objectives (yes/no)	**N/A**		
Appropriate research design (yes/no)	**N/A**		
Appropriate sample recruitment (yes/no)	**N/A**		
Appropriate data collection (yes/no)	**N/A**		
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**		
Ethical issues considered (yes/no/partially)	**N/A**		
Rigorous data analysis (yes/no)	**N/A**		
Credibility			
Findings explicitly stated (yes/no)	**N/A**		
Findings discussed in relation to original research question (yes/no)	**N/A**		
Adequate discussion of conclusions (yes/no)	**N/A**		

CRITERIA	187	188	189
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Beyond study scope; critical analysis of existing and emerging healthcare information security standards.	**No.** Describes a wide-area network connecting a hospital drug informatics center with a university's computer network; no evaluation component.	**No.** Discussion piece focusing on the integration of laboratory information into clinical processes.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	190	191	192
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Discussion piece focusing on factors driving restructuring of laboratory services in Canada and IT capabilities to support it.	**No.** Focuses on design & implementation of a computerized order entry system in ER at a single site; no evaluation component.	**No.** Commentary focusing on the development of a master patient index in an integrated delivery system.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	193	194	195
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Discussion focusing on a knowledge-based, problem-oriented system as an alternative to existing computerized patient record systems.	**No.** Survey of acute care facilities in the United States regarding master patient index core elements and practice patterns.	**No.** Discussion piece focusing on patient master index data integrity.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	196	197	198
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on telehealth.	**No.** Discussion piece; concept of the Unique Patient Identifier (UPID) and the Master Patient Index (MPI) are debated.	**Partially.** Focus on the integrated multimedia electronic patient record at the Department of Veterans Affairs.
Identifies areas for further research (yes/no)			**No**
Included in annotated bibliography (yes/no)			**No.** Abstract only; few details provided.
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	199	200	201
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Survey to assess potential information sources for identifying new health care technologies.	**No.** Overview of the Electronic Patient Record (EPR) Programme in the NHS.	**No.** Commentary focusing on barriers to adopting computer-based patient records.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	202	203	204
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Interview with Erica Drazen regarding the future of the computer-based patient record.	**No.** Focuses on benefits of computerized patient records; not presented as an evaluation study.	**No.** Discussion piece focusing on the electronic patient record as it relates to dental practice.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	205	206	207
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Technology focus.	**Partially.** Focuses on an evaluation of user satisfaction with an EMR; identifies indicators for evaluation; one site only.	**No.** Discussion piece focusing on the use of clinical information systems in the era of managed care.
Identifies areas for further research (yes/no)		**No**	
Included in annotated bibliography (yes/no)		**Yes**	
Rigor			
Purpose/goal clearly stated (yes/no)		**Yes**	
Clear objectives (yes/no)		**No.** Not stated.	
Appropriate research design (yes/no)		**Yes**	
Appropriate sample recruitment (yes/no)		Limited to one physician group.	
Appropriate data collection (yes/no)		**Yes**	
Relationship between researcher and participants clearly described (yes/no/partially)		**No**	
Ethical issues considered (yes/no/partially)		**No**	
Rigorous data analysis (yes/no)		**Yes.** Descriptive statistics and correlation analysis.	
Credibility			
Findings explicitly stated (yes/no)		**Yes.** Correlation results not as explicit.	
Findings discussed in relation to original research question (yes/no)		**Yes**	
Adequate discussion of conclusions (yes/no)		**Yes**	

CRITERIA	208	209	210
Relevance			
Relevant to our research question (yes/no/partially)	**No.** Focuses on adverse drug reactions at a VA hospital.	**No.** Review paper focusing on clinical practice guidelines.	**No.** Transcript of an AMIA debate regarding government intervention in health information infrastructure.
Identifies areas for further research (yes/no)			
Included in annotated bibliography (yes/no)			
Rigor			
Purpose/goal clearly stated (yes/no)			
Clear objectives (yes/no)			
Appropriate research design (yes/no)			
Appropriate sample recruitment (yes/no)			
Appropriate data collection (yes/no)			
Relationship between researcher and participants clearly described (yes/no/partially)			
Ethical issues considered (yes/no/partially)			
Rigorous data analysis (yes/no)			
Credibility			
Findings explicitly stated (yes/no)			
Findings discussed in relation to original research question (yes/no)			
Adequate discussion of conclusions (yes/no)			

CRITERIA	211	212	213
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Literature review on information system success; introduces a model for evaluating information system success.	**Yes.** Discusses use of the original DeLone & McLean IS Success Model and proposes updated model for measuring IS success.	**Partially.** Commentary on transformation of the VA healthcare system through implementation of a computerized patient record system.
Identifies areas for further research (yes/no)	**Yes**	**Yes**	**No**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**No**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as research article.	
Clear objectives (yes/no)	**N/A**	**N/A**	
Appropriate research design (yes/no)	**N/A**	**N/A**	
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	
Appropriate data collection (yes/no)	**N/A**	**N/A**	
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	
Rigorous data analysis (yes/no)	**N/A**	**N/A**	
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	

CRITERIA	214	215	216
Relevance			
Relevant to our research question (yes/no/partially)	**Yes.** Study of 6 VA hospitals to identify indicators of success of an integrated order entry system.	**No.** Uses a cognitive approach to evaluating usability and learnability of a computerized patient record system.	**Partially.** Compares documentation of clinical notes in paper-based and EMR; pre/post-implementation design.
Identifies areas for further research (yes/no)	**No**		**Yes**
Included in annotated bibliography (yes/no)	**Yes**		**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**Yes**		**No.** Not clearly stated.
Clear objectives (yes/no)	**No.** Not stated.		**No**
Appropriate research design (yes/no)	**Yes**		**Yes.** Pre-/post-implementation design.
Appropriate sample recruitment (yes/no)	**Yes**		**Yes.** But limited to small sample size.
Appropriate data collection (yes/no)	**Yes**		Not described
Relationship between researcher and participants clearly described (yes/no/partially)	**Partially**		**No**
Ethical issues considered (yes/no/partially)	**No**		**No**
Rigorous data analysis (yes/no)	**Yes**		**No**
Credibility			
Findings explicitly stated (yes/no)	**Yes**		**Yes.** But limited findings presented.
Findings discussed in relation to original research question (yes/no)	**Yes**		**No**
Adequate discussion of conclusions (yes/no)	**Yes**		**No**

CRITERIA	217	218	219
Relevance			
Relevant to our research question (yes/no/partially)	**Partially.** Discusses Donabedian's 7 supporting pillars of quality & 11 essential principles on the design, effectiveness & operation of health care systems.	**Yes.** Discusses the use of a Total Quality Management Framework for assessment of benefits associated with health information systems.	**Yes.** Discusses the use of a Framework for IS Action Research.
Identifies areas for further research (yes/no)	**No**	**Yes**	**Yes**
Included in annotated bibliography (yes/no)	**Yes**	**Yes**	**Yes**
Rigor			
Purpose/goal clearly stated (yes/no)	**N/A.** Not assessed as research article.	**N/A.** Not assessed as a research article.	**N/A.** Not assessed as a research article.
Clear objectives (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate research design (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate sample recruitment (yes/no)	**N/A**	**N/A**	**N/A**
Appropriate data collection (yes/no)	**N/A**	**N/A**	**N/A**
Relationship between researcher and participants clearly described (yes/no/partially)	**N/A**	**N/A**	**N/A**
Ethical issues considered (yes/no/partially)	**N/A**	**N/A**	**N/A**
Rigorous data analysis (yes/no)	**N/A**	**N/A**	**N/A**
Credibility			
Findings explicitly stated (yes/no)	**N/A**	**N/A**	**N/A**
Findings discussed in relation to original research question (yes/no)	**N/A**	**N/A**	**N/A**
Adequate discussion of conclusions (yes/no)	**N/A**	**N/A**	**N/A**

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