

Applying Methodology to Electronic Medical Record Selection

Anne Holbrook^{a, b}, Karim Keshavjee^a, Sue Troyana^a, Mike Pray^c, and Peter T. Ford
for the COMPETE Investigators^c

^a Centre for Evaluation of Medicines, St. Joseph's Hospital,
Level P1 - 105 Main Street East, Hamilton, Ont., Canada L8N 1G6

^b Division of Clinical Pharmacology, Department of Medicine,
McMaster University, Hamilton, Ont., Canada L8N 1G6

^c Hamilton-Wentworth Family Medicine, Inc., Hamilton, Ont., Canada L8N 1G6

1. Introduction

As health care becomes ever more integrated, community based and quality demanding, electronic medical records (EMRs) become necessary supporting technology. Potential advantages over current paper-based systems include faster, portable and more reliable access to charts, instantaneous access to decision support from the simple (drug interaction flags) to the complex (patient-specific messages, re: prescribing recommendations), ability to rapidly formulate patient summaries for referrals and letters, integration of laboratory and pharmacy data directly into the patient record, ability to query the practice population to support preventive health manoeuvres or research, and tighter security [1, 2, 3, 4 and 5]. The validity of many of these claimed advantages in mainstream primary care remains unproven.

The COMPETE (Computerization of Medical Practices for the Enhancement of Therapeutic Efficacy) study, the first of its kind in Canada, aimed to study the entire process of computerizing community-based primary care physicians in Southwestern Ontario [6]. This included research on EMR selection, willingness-to-pay by physicians, change management, EMR implementation, provider and patient privacy concerns, and automated, EMR-based prescribing review and intervention.

An early phase of the study involved the development and application of a rigorous EMR software assessment process. This degree of rigor applied to EMR selection has not previously been described in the literature. We present here our methodology and results.

2. Methods

A literature review of MEDLINE and EMBASE, from inception to March 2003 using keywords "medical records systems, computerized" as MESH heading and "selection" as text word yielded no relevant hits. At the time of our selection process, attendance at the standard informatics meetings (HIMMS, TEPR, AMIA, COACH) and review of their proceedings revealed (a) no discussions of EMR selection within a standard health technology assessment approach, (b) emphasis on EMRs based in hospitals or large HMOs or clinics with centralized clinicians and IT staff. Our target population was primary care in the usual small office, community practice. Therefore, a software selection team, which comprised of technical, clinical and research methodology expertise was assembled to carry out all phases of the subsequent evaluation. Specifically, team members combined expertise in the assessment of hardware and

software, database and network configurations, user interface, feasibility in primary care, EMR content and research methodology. The main working premises of the group included the following:

The “average” Ontario family physician is in solo or small group fee-for-service community practice, is the gatekeeper for all health services, does not personally use a computer in the office (<5% using EMR in practice) and sees 25–60 patients per day. Virtually all physicians bill for services electronically.

EMR data architecture is a key variable. Since COMPETE is examining clinical outcomes, utilization and processes of care, standard database designs with coded data are preferable to text entry EMRs.

Physician usability of the EMR is a major issue. Interfaces inhibiting speedy, intuitive, flexible charting are likely to fail.

Measures to protect patient privacy are essential.

The selected EMR software must be compatible with provincial and national health care developments, which may involve data and EMR standards but not financial subsidization.

Our research requires a functional EMR with electronic billing, scheduling, charting, prescription writing and the ability to extract non-identifiable data, as baseline. Electronic laboratory and hospital communications are to follow.

At this point, a multi-staged evaluation was planned and executed. The stages are summarized in **Table 1** and are described as follows:

Surveys, individual interviews and focus groups with local family physicians regarding: determinants of interest in EMR and barriers to participate, desired functionality for an EMR, and willingness to pay for an EMR. The surveys, once tested for face and content validity, were mailed to 101 area family physicians who had expressed interest in EMRs. The focus groups and individual interviews were carried out with 27 family physicians recruited using the Canadian Medical Directory. Both sample sizes were sufficient to achieve information redundancy [7].

Development of a detailed EMR evaluation form. This was developed from learnings at conference presentations and discussions with EMR vendors, EMR-using physicians and study investigators on the merits of specific EMR features. Each feature was evaluated on a five-point Likert scale with additional space for comments. The form itself with its 101 items in 14 topic domains (**Table 2**) or reference to the topic domains was used for subsequent stages. The complete evaluation form is available at the COMPETE web site (<http://www.compete-study.com/>).

A scan of medical journals, health technology journals, the internet, and attendance at EMR conferences for functional and available EMRs. In specific, we sought EMRs that were:

- available for sale in North America,
- functional for ambulatory primary care,
- functional beyond solely billing and scheduling (i.e., at least the charting of patient encounters), and

- compatible with a Windows operating system.

Initial checklist review of features of relevant EMRs by two family physicians recruited to serve as pilot sites for the project. This stage of the review was based on live demonstrations, working copy of the EMR and self-running demonstrations with manuals.

A full one and one-half day live demonstration event consisting of:

- ✦ In-person, structured EMR demonstration by vendors with detailed quantitative review of features by a team of eight EMR-using physicians, technical staff and researchers. These were held in the hospital's computer laboratory. The EMR-using physicians were chosen to represent a range of community family medicine care (solo and group) and payment models, similar to physicians we wished to recruit into the study. Vendors were, at the time of invitation, notified that a structured evaluation was planned where they would be asked to display and discuss their product according to a facilitated agenda. They did not have access to our evaluation form. Each reviewer had the detailed COMPETE EMR evaluation form (as per **Table 2**) in front of them and scored items as the presentation progressed.
- ✦ Shorter demonstrations of each EMR for a group of local family physician “peer influentials” with questionnaire ratings and feedback on interest in EMRs, demographics of practice, user interface, customizability and overall impression of acceptability in their offices. None of these physicians had worked with an EMR in their practice.
- ✦ An evening “open house” presentation by each of the vendors for all interested area family physicians. This was held to create interest in EMRs; no formal feedback was required. This stage involved more than 100 family physician practices.

Site visit evaluations by clinical and technical team members. These were in two parts. Each vendor nominated two or three family physician groups who used their EMR and were willing to accommodate observers. A subset of clinical and technical team members spent a day at one of the nominated practices observing the EMR in use and interviewing practice physicians and staff. Vendor personnel were not present at these visits. As well, two technical team members visited each vendor's headquarter offices primarily to view and discuss the data model of the product. These visits were generally 3 - 4 half-days in length.

An evaluation of a working copy of each of the four finalist EMRs by 12 family physicians who were interested in participating in the study. These sessions were structured, one-on-one half-days with the same technical team member. These were set up as a brief introduction to the product followed by the physician attempting to chart two representative types of patients. First, an “easy encounter”, where the physician was asked to chart a well baby check-up, a sore throat encounter or a blood pressure follow-up, followed by a “complex encounter” where the scenario involved a patient with musculoskeletal complaints and psychosocial issues. The physicians completed questionnaires evaluating their practice demographics, charting style, their opinion on the importance of availability and ease of access to various features of EMRs, and their

rating of each of the four EMRs in terms of user interface, potential mastery of the software and order of preference for each system.

The evaluation finals involved the two top EMR systems identified from previous stages and proceeded systematically through three phases:

- ✦ “expert user” demonstration. Each vendor company identified an experienced, expert family physician user who provided a demonstration of their use of the system (in the absence of vendor personnel),
- ✦ collation of all previous evaluation stage ratings into a scoring matrix with three main themes: database, user interface/usage and support issues, and
- ✦ negotiations in person with vendor executives regarding compatibility of our research EMR implementation agenda with the vendor's strategic direction.

Table 1. Stages of systematic EMR evaluation

Survey of interest, barriers, desired functionality, willingness to pay
Development of detailed EMR evaluation form
Broad search for available EMR systems
Brief review of features of EMRs
Detailed vendor demonstration of EMR features in person
Site visits to EMR system user practice and vendor headquarters
User evaluation of working copy of EMR using typical case scenarios
Finalist evaluations and negotiations

Table 2. EMR feature domains evaluated

Log-on/log-off procedures, security
Scheduler, patient database
Charting encounters
Prescriptions
Chart summary/cumulative patient profile
Diagnoses, procedures, reports
Access to on-line information
Referral letters
Querying the database, practice research
Health maintenance
Patient education
Laboratory orders and retrieval
Communications and productivity
Other system or vendor features

3. Results

The entire EMR selection process took 18 months to complete. As we proceeded through the early evaluation stages, it became clear that there was a wide range of opinions amongst family physicians about EMRs. From our study catchment community of approximately 700 family physicians, 10–15% were sufficiently interested in EMRs to attend information sessions or participate in evaluations. Another 10–20%, generally older or part-time physicians, were opposed to using computers for their patient care under any circumstances. Interest in EMRs primarily revolved around the perceived potential to improve office efficiency, improve the quality of charting and access to quality of care enhancements such as reminders and guidelines [8 and 9].

All physicians named the cost of EMR setup and support as a major barrier to computerizing. Many also felt that health data privacy concerns and their own ability to convince their practice staff and physician colleagues to computerize were significant impediments [10]. The costs of computerization were articulated as not just direct costs, but also the time required to investigate EMRs, train to use a system and the time lost to actual switchover and ramping up to full use. Willingness to pay for an EMR system was assessed quantitatively. The result suggesting that family physicians were willing to pay approximately one-third of the actual cost of a full client-server EMR set-up [9].

Although 40 systems advertised themselves as EMR software for North American community primary care settings, upon closer scrutiny fewer than 15 were considered full EMRs capable of supporting a paperless office. Elimination of those not interested in gathering clients in Canada or not available for a Windows environment reduced the list to seven systems.

The family physician feature checklist review was based on a live demonstration of the software (five systems) and demonstration disks with manuals for two systems where an in-person visit could not be arranged. This review readily identified four systems as more functional than the rest and worthy of more detailed evaluation.

The detailed EMR evaluations (see [Table 2](#)) took approximately 3 hours for each vendor. Summary scores by section are presented in [Fig. 1](#). EMR 1 was rated lower than the other three systems, primarily because its development was incomplete. By the end of each session, raters were satisfied with their understanding of the “look” of the system—the interface and the clinical requirements. However, there was considerable inter-rater variability in scoring for many domains, suggesting either widely varying preferences for EMR interface and features or simply fatigue with our rapid-paced evaluation procedure. Systems with a higher quality database structure necessary to support the research objectives of the study and the health maintenance/practice query objectives tended to score lower on user interface issues than the text-based systems. None of the EMR systems had a large network of installed primary care users. Technical team members were still dissatisfied at the end of this stage with their grasp of any of the systems' underlying database structure or data model. As well, there was concern among raters that our evaluations might reflect more the charm and speed of the person demonstrating the system rather than the merits of the system itself. These two latter issues were resolved in subsequent stages.

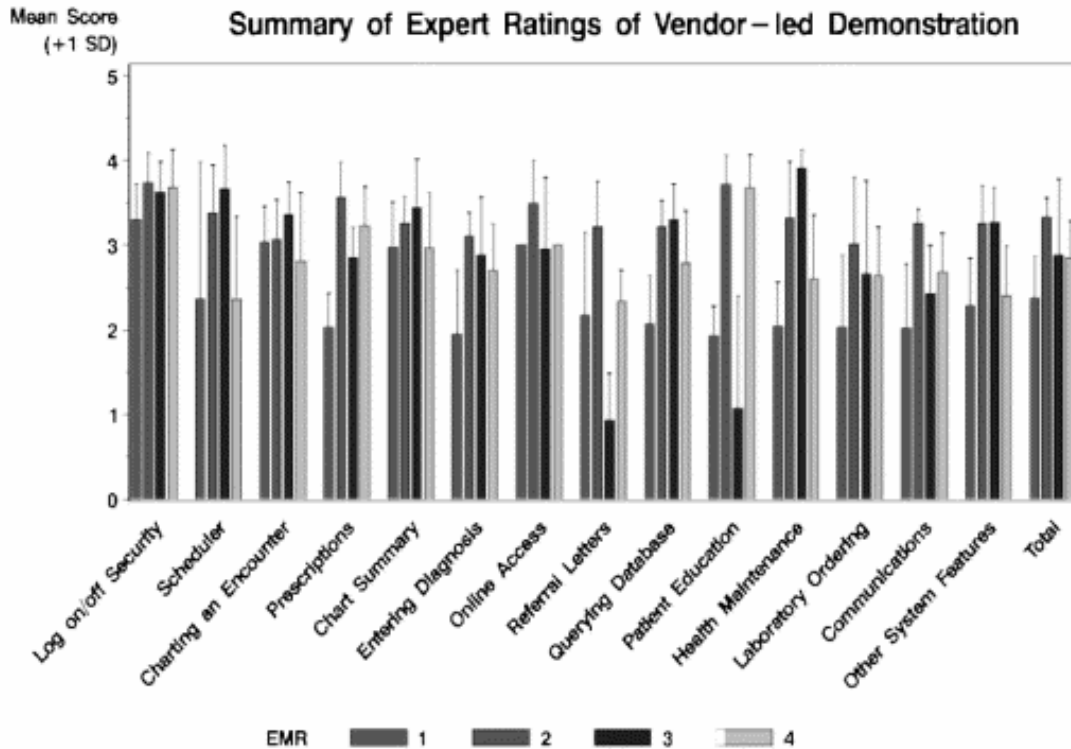


Fig. 1. Summary of expert ratings of vendor-led demonstration.

The less structured and much shorter evaluations by peer influential family physicians ($n=25$) suggested that all systems would be acceptable but the summation of their evaluations suggested that EMR 4 was less desirable. None identified the incompleteness of EMR 1.

Visits to EMR clinical user sites were revealing and sobering for several reasons. In a large EMR practice, less than 10% of the physicians actually used the computer while the rest dictated their notes. This necessitated transcription expenses and eliminated any opportunity for real-time clinical decision support. In another teaching family practice, use of the EMR had withered for lack of a physician champion and in-house information technology support. Conversely, practices flourishing with EMRs tended to be solo or small groups where the physician EMR champion was adept with keyboards and was knowledgeable about hardware and software problem solving. All of the EMR practices had complaints about their vendor's development speed, difficulties in training new physicians and staff, cost of the systems and the lack of integration with their local laboratories, pharmacies and hospitals.

Visits to all vendor sites, while intended to allow our technical team members a full view of the software architecture, instead tended to clarify the tenuous financial situation of the companies. These visits also confirmed that claims made about available features or database qualities were frequently exaggerated. For example, only at this point did it become evident that EMR 2, previously highly rated, was not truly a Windows product but a DOS program within a Windows shell.

For the seventh stage, although selected from different practice styles and locations, the family physicians were consistent in their relative ratings of working copies of each of the four systems (Fig. 2). Three systems were judged to have good user interfaces, to be usable in their practices with training and to have the potential to advance their quality of care. EMR 2, previously highly rated in the vendor-led demonstration, in this phase was rated significantly lower than the other three systems. Evaluators ranked access to a chart summary, problem list, history of present complaint, diagnoses, medication list, drug-allergy checks and templates or macros for chart entry, as priority. These were rated more highly than a direct electronic laboratory link, access to practice guidelines, patient information resources and structured (e.g. ICD-9) coding of diagnoses.

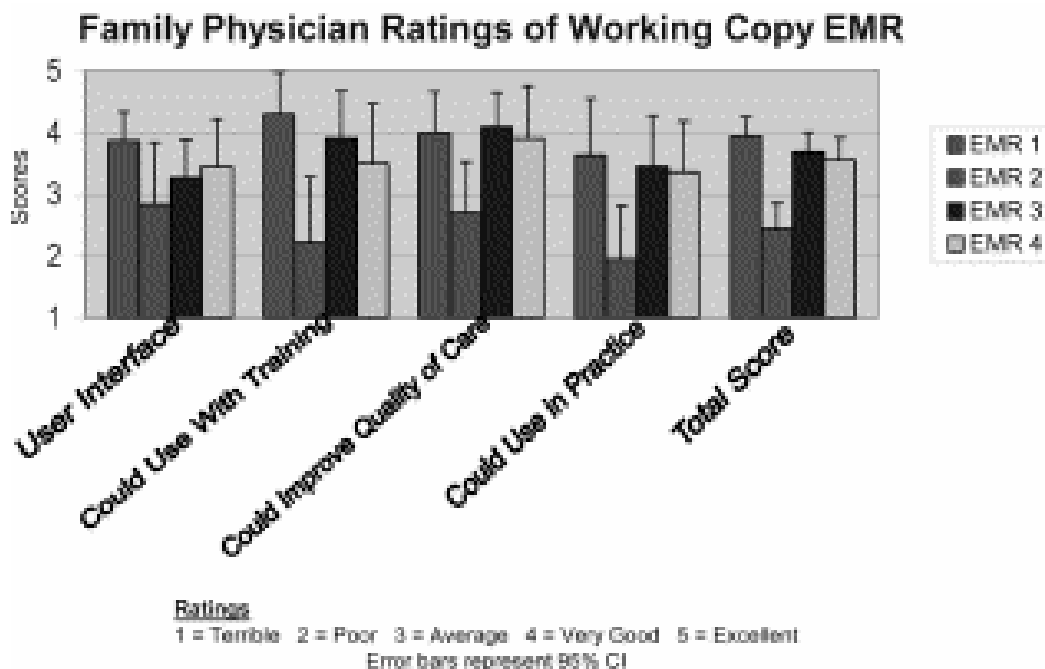


Fig. 2. Family physician ratings of working copy EMR.

At this point, a reiteration of the goals and objectives of the project in light of the evaluation process to date was undertaken by the EMR selection team. The working premises developed at the onset were judged to still be highly relevant. In addition, we endorsed our research objective to provide real time, patient-specific clinical decision support to physicians. After recapping all of our evaluation information to that point, two EMR systems were judged to be most capable of this rigour.

Entering the final evaluation stage, it became clear that trade-offs were yet necessary. Our scoring matrix revolved around three main domains: usability, database quality and user support issues. The software with the more user-friendly interface did not appear to provide the high quality structured database “back end” of its competitor and vice versa. User support did not appear to differ significantly between the two. Each of the two finalist vendors, after a full review of our study requirements, gave a presentation. EMR 3, with its structured, extractable database, Pen Windows environment, Ontario billing capacity, and well-developed charting templates was selected. However, it was

recognized that the other finalist, EMR 4, had superior customizability, full user query capabilities and full health maintenance modules, all features that EMR 3 did not have.

4. Discussion

To our knowledge, this is the first description of a systematic, multifaceted, rigorous team approach to the methodology of EMR selection. An update of our previous MEDLINE, EMBASE, conference proceedings and internet search again revealed nothing similar. While Google claimed more than 400,000 hits on “EMR selection”, scrutiny of the first 100 revealed that more than 75% were advertisements, 2% were on topic but none described a systematic approach. It is highly unlikely that the highest quality of evidence - a randomized, controlled trial comparing EMR systems in practice—will be carried out in order to guide selection in the future. However, for a technology about to impact on every provider in health care, it is shocking to consider the scarcity of quality literature on this important topic. Several publications describe principles or features to consider in EMR selection [1, 11, 12, 13, 14, 15 and 16], surveys of EMRs [17, 18, 19, 20, 21, 22 and 23], or methods for structured EMR vendor assessments [24, 25 and 26]; none outline a comprehensive process or “critical pathway” approach as described here. Given the substantial commitment in time, energy and finances required for physicians to evolve their practices from paper to computer, they should expect to have a tested approach available for use in evaluating EMRs. It is ironic that far more resources and oversight are applied to less important aspects of health care, for example therapies for short-term relief of non-life-threatening problems such as heartburn, headache or hemorrhoids, than are applied to systems affecting every aspect of thousands of patients' care every day for the life of the practice [27].

Several points emerged from our laborious EMR review. First, no perfect system exists. Our anxiety over missing “the optimal EMR” which might be just at the point of release at times overtook our more rational desire to select a system with a user base and led to delays in finalizing our choice. On the other hand, the logistics of scheduling, completing and evaluating each stage of the evaluation would not have allowed for a timeline much shorter than the 18 months. In retrospect, each step of the evaluation added useful information and could not have been deleted.

Second, frequent revisiting of the goals, objectives and premises was helpful to anchor evaluation at each stage, particularly when non-team physicians were involved. The research goals, which required data extraction, analysis and feedback messages in real time made a structured, standard EMR database an absolute requirement for our technical team members. On the other hand, clinicians argued strongly that an intuitive and flexible user interface would be required, otherwise no data would be entered with which to consider analyses. Ideally, a single system would hold both attributes but such a system was not found in our extensive review. The possibility of developing our own EMR modules, perhaps concentrating on patient problem list, prescriptions and diagnostics only, was raised several times only to be rebuffed by concerns about development time, costs and ongoing support.

Third, each stage of the evaluation raised new issues to be addressed in subsequent stages. The members of both clinical and technical teams remained uneasy about each

product's clinical usability, data retrieval ability and vendor viability until nearly the final selection day. In particular, concern in both groups about exaggerated vendor claims beyond ability to deliver triggered an ever more detailed review of aspects of each system with each stage of evaluation. These concerns were often realized—for example the “Windows” system which was really DOS, the system claiming a large user base but not a single family physician user for us to interview, a system claiming excellent database structure but no query tool available for physician users, etc. Thus, the entire selection process, in some respects, was an elaborate risk management exercise with the goal of decreasing the chances of failure of the project [28 and 29]. Subsequent implementation and follow-up provided validation of our process, in that more than 80% of practices implemented maintained high-quality use of their EMR after 2 years. This is substantially higher than success figures of approximately 20–30% oft quoted by the vendors themselves.

Fourth, the EMR marketplace is volatile and evolving constantly. Several well-developed US-based EMRs disappeared or merged with competitors and were shelved during the course of our investigation. Thus, we were usually evaluating a moving target and vendor stability is still a major concern. Finally, especially ironic to the researchers on the team, our structured, quantitative assessments applied at several stages were often less contributory to our ultimate decision than the subjective, more consensus than evidence-based evaluations.

We intentionally do not name the EMR systems in this report for three reasons. First, no matter how explicit and open was our approach, we have acknowledged the necessarily subjective nature of many parts of the evaluation and others may disagree with our summary assessment. Our intention is not to denigrate or downplay the huge effort and intellectual capital required to develop any functioning EMR. Second, the focus of this paper is meant to be on the methods, the process of EMR selection rather than the systems themselves. Third, as mentioned, the better systems are constantly evolving and ratings are likely time limited to less than 2 years.

In summary, we have developed a comprehensive, structured approach to EMR selection. Although our project involves community-based primary care where the majority of health care is delivered and no IT support or project management is provided, the general approach is highly relevant to institutional settings as well. The importance of a multidisciplinary team (clinical, technical, and evaluation expertise) with commitment to shared goals and objectives for the EMR installation cannot be overemphasized.

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References

1. G.K. Johnson, Functional requirements of a computer-based patient record system. *Healthc. Financial Manag.* **50** (1996), pp. 54–62.

2. S. Ornstein, Electronic medical records in family practice: the time is now. *J. Fam. Pract.* **44** 1 (1997), pp. 45–48.
3. Institute of Medicine Committee on Improving the Patient Record, The computer-based patient record: an essential technology for health care, National Academy Press, Washington, DC, 1991.
4. Anon, OMA President addresses Standing Senate Committee (Kirby Commission) on the future of health care in Canada, *Ont. Med. Rev.* **68** (10) (2001) 17–19.
5. Canada Health Infoway: Paths to Better Health. Final report, Advisory Council on Health Infostructure, Ottawa, Ont., Health Canada, 1999.
6. COMPETE II: Computerization of Medical Practices for the Enhancement of Therapeutic Effectiveness, 2003. Available from: <http://www.compete-study.com>.
7. M. Giacomini, D. Cook and G. Guyatt, Therapy and applying the results: qualitative research. In: G. Guyatt and D. Rennie, Editors, *Users' Guides to the Medical Literature: A Manual for Evidence-Based Clinical Practice, The Evidence-Based Medicine Working Group*, American Medical Association, Chicago (2002), pp. 433–448.
8. H.R. Strasberg, F. Tudiver, A.M. Holbrook, G. Geiger, K. Keshavjee, Moving towards an electronic patient record: a survey to assess the needs of community family physicians, *Proc. AMIA Fall Symp.* (1998) 230–234.
9. K. Keshavjee, R. Kyba, P. Naisbitt, A.M. Holbrook, Electronic medical records in family practice: what drives physician interest and how much are they willing to pay?, in: *Proceedings of Toward an Electronic Patient Record '98*, Vol. 3, 1998, pp. 30–33.
10. K. Keshavjee, D. Willison, A.M. Holbrook, K. Nair, S. Troyan, for the COMPETE Investigators, Patient and provider health data privacy concerns, in: *Proceedings of e-health 2001 Conference*, 2001, pp. 58–59.
11. M.G. Kahn. *The computer-based patient record and Robert Fulghum's 16 principles: clinical computing* **12** 253 (1995), p. 258.
12. H.D. Covvey, Evaluating a system's "look and feel". *Ont. Med. Rev.* **62** (1995), pp. 38–45.
13. H.D. Covvey, Taking care of business. *Ont. Med. Rev.* **63** (1996), pp. 83–86.
14. J.H. Carter, *Electronic Medical Records: A Guide for Clinicians and Administrators*, American College of Physicians, Washington, DC, 2001.
15. M. Leavitt, Selecting an EMR, GE Medical Systems, 2002. Available from: http://www.medicallogic.com/emr/user_experience/selecting_emr.html.
16. K.B. Eden, Selecting information technology for physicians' practice: a cross-sectional study. *BMC Med. Inform. Decis. Mak.* **2** 1 (2002), p. 4.
17. S.M. Ornstein, E. Schaeffer, R.G. Jenkins and R.L. Edsall, A vendor survey of computerized patient record systems. *Fam. Pract. Manag.* **3** (1996), pp. 35–48.

18. Electronic Medical Records, 2003 (4-23-2003). Available from: <http://www.aafp.org/x432.xml>.
19. Fourth Annual MRI Survey of Electronic Health Record Trends and Usage Sponsored by SNOMED®, Medical Records Institute, Newton, MA, 2002. Available from: <http://www.medrecinst.com/resources/survey2002/index.shtml>.
20. A. Brookstone, Selecting the right EMR software, The Medical Post, Toronto, ON, 2003. Available from: <http://www.medicalpost.com/mpcontent/article.jsp?content=/content/EXTRACT/RAWART/3805/39A.html>.
21. W. Brown and P. Berwick, OMA 1999 survey of medical office computer software system suppliers. *Ont. Med. Rev.* **66** 11 (1999), pp. 16–23.
22. S. Rehm and S. Kraft, Electronic medical records: the FPM vendor survey. *Fam. Pract. Manag.* **8** 1 (2001), pp. 45–54.
23. B. Kittelson, Physician practice management systems, *Healthc. Inform.*, (2001) 33–45. Available from: <http://www.healthcare-informatics.com>.
24. L. Hill-Einbinder, J. Bleiberg-Remz, D. Ochran, Mapping clinical scenarios to functional requirements: a tool for evaluating clinical information systems, in: J.J. Cimino (Ed.), AMIA Conference proceedings, October 26–30, 1996, 747–751.
25. T. Knox, After the RFP, a balanced scorecard approach to vendor selection, in: Proceedings of HIMSS Conference and Exhibiton 2001, Poster Session 15, 2001.
26. L. Guariglia, W. Mendes, Evaluating and selecting an electronic medical record system: a guide for small physician practices, 2002, Outlook Associates, Inc., Long Beach, CA.
27. E. Mitchell and F. Sullivan, A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980–97. *Br. Med. J.* **322** (2001), pp. 279–282.
28. B.L. Goddard, Termination of a contract to implement an enterprise electronic medical record systems. *J. Am. Med. Inform. Assoc.* **7** 6 (2000), pp. 564–568.
29. K. Keshavjee, S. Troyan, K. Langton, A.M. Holbrook, A. Nagji, D. Topps, et al., Successful computerization in small primary care practices: a report on three years of implementation experience, in: Proceedings of E-Health 2001, Toronto, p. 12.

Corresponding Author.

Present address: Centre for Evaluation of Medicines, St. Joseph's Hospital, Level P1 - 105 Main Street East, Hamilton, ON, Canada L8N 1G6. Tel.: +1-905-522-1155x5269; fax: +1-905-528-7386