

Chapter 2

Integrating Electronic Health Records into Medical Education: Considerations, Challenges, and Future Directions

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Abstract Electronic health records (EHRs) and related health information technologies are currently being implemented worldwide. Indeed, it is expected that electronic medical records (EMRs) will eventually become routinely used by all physicians. Such information technology promises to not only revolutionize and modernize health-care practice but also change medical education as new approaches to integrating this technology into the undergraduate education of physicians become a requirement. Despite the emerging importance that EMRs play in health care, there is little published work describing efforts to integrate this technology into medical curricula. This chapter first describes the need to bring electronic medical records into undergraduate medical education, including a review of the challenges faced in doing so. Discussed next is a project that was undertaken to integrate the use of EMRs into a problem-based module of an undergraduate medical education program. This involved providing over 200 medical students and faculty (across three geographically dispersed sites) with information about the patient “case of the week”

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via an EMR that was specifically modified for use in medical education. The intent of the project was to teach medical students about key aspects of the EMR itself as it was used to support problem-based medical education. Results indicated that EMR technology can be usefully integrated into problem-based medical education. Implications, challenges, and future extension of the work are also discussed.

2.1 Introduction

Health information technologies promise to transform and revolutionize health care. Information systems such as electronic health records (EHRs) are expected to lead to improved and streamlined health care by allowing for electronic entry and access to health information by physicians, nurses, and allied health professionals. Such technology will also allow for value-added capabilities such as automated decision support (e.g., including alerts and reminders and electronic guidelines) and an electronic interchange of information across hospitals, regions, and even countries (Shortliffe and Cimino 2006). Along these lines, electronic medical records (EMRs)—electronic patient records used by physicians in their offices and clinics—are expected to become widely adopted in North America and internationally over the next few years as there is a move to use these systems to replace patients' paper records; some countries have already achieved near universal use of this technology by primary care physicians. As these information technologies become more widely used, it will become increasingly important that training around the use of EMRs be included and integrated into the education of future physicians.

Despite the importance and transforming nature of this technology, a review of recent literature reveals that health-care professionals of the future (i.e., undergraduate medical students) have limited exposure to EMR training as part of their undergraduate education (Otto and Kushniruk 2009). In addition, despite the efforts underway to increase the use, awareness, and adoption of EMRs, barriers and challenges have nevertheless been reported regarding their integration and adoption (Bates 2005; Jha et al. 2006; Kucukyazici et al. 2008; Nohr and Boye 2008). Indeed, in North America, rates of adoption of EMR technology by primary health-care physicians is well below 50%, with many physicians still using paper records in their offices (Jha et al. 2008). In order to prepare medical students for the type of practice they are expected to encounter upon graduation—a practice that will likely involve the use of complex information technologies such as the EMR—there is a need to integrate this technology directly into their undergraduate education. Researchers and practitioners argue that it will be essential for medical students to receive training regarding the effective use of EMRs in routine practice, including an overview of their benefits and limitations (Borycki et al. 2009; Speedie and Niewoehner 2003). By incorporating EMR training in medical students' undergraduate education, it promotes the adoption and use of this technology by graduating physicians who see EMRs as a regular part of their routine medical practice (Borycki et al. 2011; Rouf et al. 2008).

One group whose aim is to explore and research issues such as the gap in medical education around EMR integration is the Technology-Enabled Knowledge

Translation Investigative Centre (TEKTIC). In fact, the main objective of TEKTIC's project "*Bringing Information Technology to Small Group Teaching in Medical Education: Knowledge Translation in Educational Practice*" was to investigate how EMRs could be effectively integrated into medical education. The goal of this project was to explore new ways of integrating EMRs into medical curricula to provide undergraduate medical students with essential EMR-related knowledge and skills.

Certainly, there is a need to update and modernize health professional education to include the integration of EMRs and, moreover, to formally introduce EMR training (and related information technologies) into undergraduate medical education. Despite calls from a number of respected organizations (including the Association of Medical Colleges who first raised the issue as far back as 1998) to integrate EMRs, a review of the literature indicates that EMRs have yet to be routinely integrated into medical curricula (Borycki et al. 2009, 2011; Otto and Kushniruk 2009). Krause and colleagues (Krause et al. 2006) note a potential source for the reluctant integration of EMRS into medical education that US medical programs do not formally require the integration of medical informatics into medical curricula. As a possible refutation of this, Keenan et al. (2006) reported scant-published articles describing the application of EMRs in undergraduate medical education.

Despite the dearth of information on EMR integration in medical education, there is nevertheless empirical work reflecting the efforts of researchers trying to highlight the utility of EMR integration. In recent work by Borycki et al. (2009), different approaches to integrating EHR technology in training both medical and nursing students using a range of different electronic records are described. These researchers identified the use of a web-accessible portal that houses a number of working electronic health record systems used in various ways to introduce medical and nursing students to such systems. In another effort at Leeds Medical School, students were exposed to EMRs in their medical training prior to doing clinical placements (Lea et al. 2008). Despite these isolated efforts, it is clear that few medical education programs in North America have attempted to formally expose students to the range of capabilities and the various types of commercially available EMRs they are likely to encounter, and be expected to use, upon graduation (Borycki et al. 2009, 2011).

There are a number of reasons for developing systematic approaches to supporting the integration of EMRs into health professional education. Firstly, graduates of health professional programs are expected to be able to practice effectively in the ever-changing health-care environment, including having the capability and knowledge to use information technologies in their practice. Secondly, graduates will become consumers of new health information technologies. Thus, graduates should have the knowledge to compare different EMR products, including their capabilities and their suitability for integration into graduates' practice (Borycki et al. 2009).

There are, however, a number of logistical issues that arise in bringing technologies such as the EMR into health professional education and practice. These include (1) an international shortage of health informatics specialists to set up, maintain, and customize EMRs intended for educational purposes; (2) the need for health professional students to have exposure to multiple types of systems in a variety of different educational contexts; and (3) the need for guiding educational frameworks

to support the integration of EMRs in health professional education (Borycki et al. 2009, 2010, 2011). With respect to integrating EMR information and education into undergraduate medical programs, two distinct issues arise: (1) EMRs must be introduced in a seamless and time-effective manner (i.e., their introduction must blend with existing curricula), and (2) the introduction of EMR-related technologies must be done without taking time and emphasis away from the teaching of basic biomedical fundamentals and principles of medical practice (Joe et al. 2009; Otto and Kushniruk 2009). This will require careful consideration of medical curricula and where information technology can best be introduced and integrated (i.e., identifying key “insertion points” in medical curricula for integration of EMR technology). In addition, such integration will require time, effort, and understanding by medical faculty (who themselves may have had limited exposure to this technology) to maximize the potential for improving medical education using electronic health records.

In order to effectively integrate EMR technology into medical curricula, organizing frameworks must first be considered in order to bring EMRs into health professional education (e.g., medical, nursing, health informatics, and allied health professional training and education). Kushniruk et al. (2009) have described a framework that includes a continuum of approaches and allows for the integration of information technology. These approaches range from “loose coupling” of activities involving EMRs with medical curricula to “tight” coupling of EMR directly into medical education and curricula. As an example of loose coupling, initiatives could involve having students explore EMR technologies on their own (e.g., outside of classroom activities), or having the technology integrated into a stand-alone laboratory component as part of their training. In contrast, tight coupling would involve a greater degree of integration of EMR technology with the basic teaching of medical and health fundamentals so that the technology itself becomes an integral part of the learning experience at all levels. The remainder of this chapter describes an example of a “tight” coupling initiative to bring EMR into medical education. The case study that follows presents a description of the objectives, challenges, and initial results of systematically introducing EMR technology to over 200 medical students during their fourth and final year of undergraduate education (Borycki et al. 2009).

2.2 Project Description

To explore the potential integration of EMRs into medical curricula, a project was initiated in 2007 that involved collaboration among the medical faculty across the province of British Columbia (BC) at three medical training sites: Victoria, Vancouver, and Prince George. This project also involved collaboration with several health informatics faculty members from the School of Health Information Science at the University of Victoria who had expertise in the area of design, evaluation, and adoption of electronic health record technology. In total, 240 students and faculty were involved in the pilot study. The objective of the project was to explore the integration of EMR training within a problem-based learning (PBL) module provided to all fourth-year medical students in BC during a trial run in December 2007.

Central to PBL has been the teaching of medical science within the context of clinical problems presented to students (Patel et al. 1993). In considering the 4-year medical program in the province of BC, it should be noted that curricula are linked across all the medical programs in the province using a range of telecommunication technologies (including the sharing of lectures across the different, geographically dispersed sites).

2.2.1 “Tom’s Case”

During initial reviews of provincial medical curricula, it was determined that there was a fourth-year module that could accommodate the introduction and discussion of EMRs. The module, entitled “*Preparation for Medical Practice*,” was targeted for a pilot study where students would be required to access and interact with their weekly “patient case” using EMR technology. During this particular week, the case used for discussion was “Tom’s case.” Students were provided details about “Tom,” a 45-year-old patient who presents with complaints of back pain on a background of obesity, diabetes, and poor exercise. During the week this case was discussed, a wide variety of biomedical topics were introduced within the context of Tom’s case (as a means of supporting students). This included the release of information over the week about additional details of the case and developments in terms of the patient’s condition (e.g., Tom’s back pain worsens and becomes unbearable). Throughout the week, the patient case was examined and discussed in terms of disease processes, decision-making (including finding and determining the relevant evidence base), drugs and therapeutics, communication, and ethical considerations relevant to the case. Teaching principles used in discussing the case involved a mixture of both small group problem-solving sessions and large classroom lectures (that were video-linked across sites) that covered basic medical topics presented in the context of Tom’s case.

What was different from typical iterations of this type of PBL (conducted in previous years) was the integration of an EMR into the week, along with some targeted lecture material about EMRs. Specifically, rather than obtaining course material from paper-based handouts (e.g., about Tom’s evolving condition), as had been previously done, students interacted directly with an EMR during the pilot study to (1) access basic patient information, (2) explore features such as decision support, and (3) record data and medication information using the EMR.

2.2.2 *The Electronic Medical Record Used*

An EMR designed for private medical practice was modified for use in the project (i.e., the office-based digital design EMR (by Anthologix©), which was developed by two of the coauthors of this chapter and modified to add educational features and functions based on discussions during the project). As noted above, during one

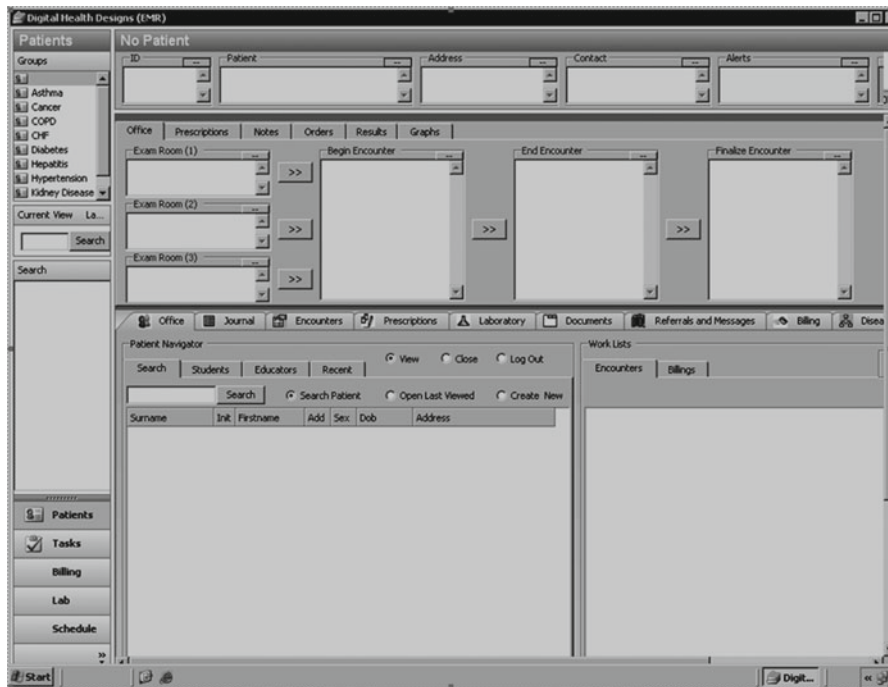


Fig. 2.1 Main screen of the EMR used to present the patient case of the week

week in December 2007, approximately 200 medical students at three distinct sites (Victoria, Vancouver, and Prince George) were introduced to concepts related to EMRs during lectures. As part of the intensive, week-long PBL module, students were asked to interact with the EMR directly in order to obtain emerging information about the patient case discussed that week (i.e., the case of “Tom’s back pain”). Whereas previously, students would have been given paper copies of descriptions of patient cases, during the pilot study the students accessed the patient case using the EMR.

In order to allow the EMR to be used in this pilot study, the EMR was modified to include a number of features that were desirable for the application of an EMR to the context of medical education (Joe et al. 2009). This included developing different roles for students and educators including a “students tab,” where students could initially log in to the system in order to select from (or “subscribe”) any of a number of patient cases posted by course instructors (e.g., “Tom’s case”). This adaptation of the EMR also included development of an “instructors tab,” whereby the course instructor could set up parameters for the case of the week (e.g., setting up the timing for when consult reports would appear). In addition, each student was able to have his/her own copy of the patient data, thereby allowing an individualized record of each student’s interaction with the EMR system. Figure 2.1 illustrates the main screen of the EMR used in the project, as it appeared to both students and instructors.

The screenshot displays the Digital Health Designs (EMR) software interface. At the top, the patient's name is MILLER, TOM (M), Age: 45y, and the encounter date is Wednesday, December 05, 2007, 9:38:22 PM. The patient's address is 1324 NEW STREET, VANCOUVER, BC, V6X 1X1. The patient's ID is 54:15, DOB is 9/20/1962, and PHN is 45y.

The interface includes a left sidebar with a list of medical conditions: Asthma, Cancer, COPD, CHF, Diabetes, Hepatitis, and Hypertension. The main window shows a list of medications with columns for Item, Date, Rx, Mode, Print, Brand Name, Chemical Name, Units, Form, Route, Take, Frequency, Instructions, PRN, and Quantity. The list includes Tylenol 6 hour extended release, Tylenol cold & flu daytime, Tylenol cold & flu nighttime, Tylenol cough, Tylenol extra strength gel, Tylenol no. 1 caplets, Tylenol no. 1 forte caplets, and Tylenol regular strength capsules.

Below the medication list, there is a section for "Drug Database" and "Prescription Profile" with a search bar and a list of drugs. The drugs listed include Tylenol 6 hour extended release, Tylenol cold & flu daytime, Tylenol cold & flu nighttime, Tylenol cough, Tylenol extra strength gel, Tylenol no. 1 caplets, Tylenol no. 1 forte caplets, and Tylenol regular strength capsules.

Fig. 2.2 Screen showing medications taken by patient of the week

Upon first logging into the system, students were instructed to review Tom's condition by clicking on the "Encounters" tab where the patient's initial information was prepopulated, including the patient's chief complaint on first contacting the physician. Subsequently, students were instructed to check what medications Tom had been prescribed (see Fig. 2.2 showing the computer display of coded medications). Students could interact with the EMR during small group sessions or individually (e.g., students could download a copy of the EMR software (including the initial patient data for Tom) to their own personal computers from a website). In addition, to facilitate exploration of the EMRs, a number of laptops were made available in the small group sessions with the software already installed and running. As students were introduced to different features of the EMR (e.g., entry of coded medications using the screen shown in Fig. 2.2), a corresponding lecture segment was presented in the large classroom setting to briefly provide context to relevant features and functions of the EMR being highlighted throughout the week (e.g., discussion of the advantages of entering medications as coded versus entering them as free text).

Throughout the week, advanced features associated with EMRs were also introduced to students, including decision-support capabilities. For example, Fig. 2.3 shows the main screen of a diabetes control panel for helping in the management of diabetes (accessed by students by clicking on the "diabetes" tab for the patient). This part of the system was introduced to students as an example of one form of

Fig. 2.3 Diabetes control panel

decision support (in the context of a classroom discussion of Tom's diabetes and the potential role of decision support). Topics related to EMRs which were discussed during the week included (1) electronic entry and retrieval of patient data, (2) integrating views of patient data using the EMR, (3) decision-support capabilities of EMR technology, (4) communication capabilities, and (5) ethical considerations regarding the use of EMRs and related technologies. Advantages, potential problems, and issues encountered in using EMRs were included in the discussion with participating medical students.

2.2.3 Evaluation

Findings stemming from this project revealed that EMR technology could be practically integrated into a problem-based medical education module. The results also indicated that a coupling of information technology within a PBL module allowed students to gain knowledge about EMRs, while concurrently learning about the biomedical aspects of patient' cases with little extra time expenditure. The same questionnaire administered at the end of each weekly session was used to assess

students' overall experience in the module. Although students rated the session favorably overall, a number of comments were made that reflected strategies for improving the EMR integration into existing curricula. These included decreasing the amount of didactic information about EMRs and increasing the amount of hands-on exposure to EMRs themselves. In addition, some students commented that by their fourth year, they would like to have had experience with a range of different systems (in particular, the specific vendor systems that the provincial government is providing funding for purchasing in their medical practice upon their graduation). One student suggested an alternative activity that involved critiquing the EMR in use and reflecting on the benefits offered by this technology.

2.3 Recommendations

Although the project successfully integrated EMR technology into a component of a problem-based medical learning module, a number of challenges were nevertheless encountered. These ranged from the technical and logistical to the educational and pedagogical. For example, early in the project, technical and logistical issues arose which thwarted the initial plan to provide ubiquitous web-based access to the EMR. To compensate for the technical issues encountered and in order to keep to the planned schedule, the software was distributed to all sites on flash drives for use in the small group sessions; it was also made downloadable (by students and faculty) from the faculty of medicine medical student website.¹ In subsequent work, remote web-based access by students to the EMR used in the study (and a number of other open-source EHRs and EMRs) has been achieved (see Borycki et al. 2009).

A second major consideration that arose from the project concerned when to expose students to EMR technology during their undergraduate medical education. As noted above, some students indicated that by their fourth year they would like to have had experience with a number of different commercially available EMRs. The issue of how early to introduce this technology is an ongoing one, with the authors of this chapter sharing the opinion that it should be introduced in the early part of the curriculum (first and second years of an undergraduate program), rather than waiting until the very end of students' studies (i.e., just prior to graduation). In addition, the need to expose students to a wide range of different commercial vendor products arose as a comment from several students and is being incorporated in subsequent work. Of particular interest is the idea of providing web-based access to a portal housing a variety of systems that can be explored by students remotely (e.g., EMRs, EHRs, and related technology – see Borycki et al. 2009 for a review).

It should be noted that even the integration of EMR in one fourth-year module required considerable effort and coordination involving course instructors, information technology personnel, and faculty members and required several months of

¹ Note: not all students downloaded the software.

lead time to plan. Currently, this author group is working on developing a plan for a larger-scale integration of EMR technology into undergraduate medical education as part of efforts to extend and enhance the current undergraduate medical education curriculum in the province. The pilot study described in this chapter provided a valuable baseline experience for further developing integration plans. Future work, however, involves plans for a more extensive evaluation of implementation initiatives. For example, instead of using the standard evaluation forms typically used in the medical program for assessment, revised assessment strategies will be incorporated to obtain more detailed and specific information and feedback about the effectiveness of the integration of EMRs into medical education – from the perspectives of both students and faculty.

In considering moving forward with the type of educational integration described in this chapter, the need for developing an additional component for evaluating students' EMR competencies (i.e., after they have taken modules that include education and training about EMRs) was brought to light. It was abundantly clear from students' feedback that students are concerned with time management; introducing "extra" topics not tested on exams has an impact on their level of motivation and on their perception of the relevance of interventions involving EMR training. To address this issue, related work (outlined in another chapter of this book by Borycki and colleagues) describes efforts currently underway to include testing medical students' acquisition of skills related to the use of EMRs. This particular project involves integrating the testing of students' EMR competencies and skills within OSCEs (Objective Structured Clinical Examination). In addition, the issue of what core skills and competencies students should possess regarding information technologies such as EMRs remains to be fully defined. In related research undertaken by this author group, the competencies that should be targeted by educational interventions involving use of EMR will be determined through interviews with faculty, students, and other stakeholders.

Finally, the work described in this chapter can be seen as part of a larger knowledge translation initiative that aims to increase skills and competencies focused around evidence-based practice of medicine (Ho 2008). As such, training students around topics such as EMRs should not be too focused on learning specific technologies, but rather around competencies related to effectively accessing, searching, and applying the most relevant knowledge in their future medical practice. It is recommended that initiatives involving EMRs in undergraduate medical education be coordinated with the introduction of allied technologies, such as online clinical guidelines, a variety of forms of clinical decision support, pervasive healthcare applications, and new and emerging technologies such as electronic communities of practice (eCOP). Future work by this team will explore integrating the EMR with electronic decision-support systems and including it in the study of evidence-based decision-making within undergraduate medical education. Extending the parameters of the current investigation supports related work in considering how to best integrate these technologies into graduate and continuing medical education.

2.4 Conclusion

It is hoped that the present work in this area will help prompt the further integration of the EMRs into the education of health professional students and improve the general understanding of this important new technology. Based on work undertaken here, it is recommended that EMRs become integrated into medical education through embedding the technology into key aspects of medical education. In particular, PBL sessions provide an opportunity for tightly integrating EMRs within medical curricula. In conclusion, bringing awareness, knowledge, and skills of emerging and essential technology such as EMRs to medical students can be considered an important area of knowledge translation in health care.

Key Messages

- Currently, there is a lack of integration of key health information technologies in undergraduate medical education (in particular the EMR).
- Medical students need to have hands-on experience with EMRs and an understanding of the capabilities of this technology, using real systems within undergraduate medical curricula.
- EMRs can be practically integrated into undergraduate medical education through both small group and classroom learning sessions.
- Education about EMRs should be integrated and brought into undergraduate medical education as early as possible.
- Students need to be exposed to a range of EMR capabilities and products prior to graduation.
- Further work along the lines described in this chapter will be needed to form the basis for larger-scale integration of EMR technology in medical curricula.

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