Educational Electronic Health Records at the University of Victoria: Challenges, Recommendations and Lessons Learned

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Abstract. There has been an acknowledged need for the integration of health technologies such as the electronic health record system (EHR) into health professional education. At the University of Victoria we have been experimenting with different models, architectures and applications of educational EHRs in the context of training health informatics, medical, and nursing students who will ultimately use this technology in their daily practice upon graduation. Our initial work involved the development of a Web-based portal that contained a number of open source EHRs and is described in this paper. In addition to the technical side, considerations around pedagogy and how best to integrate such technology into the classroom and educational experience are discussed. Finally, challenges and lessons learned from our decade of work in this area are discussed.

Keywords. Electronic health record, education, physicians, nurses, health informatics

1. Introduction

Electronic health records (EHRs) are a ubiquitous technology in a modern health care system. From clinic offices, to hospitals, to a patient's home, EHRs are used to document patient data and support health care processes and health professionals' decision making. Yet, even as this technology has become available in most health care settings around the world, more work is needed to fully develop robust educational EHRs to support the development of digital competencies in a modern health care system. Educational EHRs are electronic records that are designed to support educators and students in their learning about how to manage a patient's health and disease. Educational EHRs also help students to learn about entering patient data, alerts, reminders and clinical decision support systems that can include links to the latest evidence based research. Such systems are designed to educate students in the technologies they will be using upon graduation in real health care settings by allowing students to access and work with the technology in an educational context [1]. In this paper, the authors outline their experiences over the past 10 years in the design, development, implementation and pilot testing of educational EHRs accessible via an EHR portal on the WWW with physician, nurse and health informatics students.

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2. Overall Architecture

Our initial work in deploying EHRs for education involved setting up a web portal that would allow for remote access to several different EHRs housed on computer servers at the University of Victoria [1, 2]. This involved three layers, including: a remote access layer, a middle firewall layer and EHR network layers, which hosted several systems and databases on our servers. Users of the initial system logged in on a remote desktop (using either PC or Mac computers). They could then select from several EHRs that are currently being used in hospital and community settings (including Open Vista, OpenMRS and POND4Kids) that run on a range of operating systems using virtual machine technology. The approach allowed for up to several hundred users (e.g. students and instructors) to simultaneously access hosted EHRs and related software from virtually any location in Canada or internationally [1, 2]. Since our initial deployment, we have been working on a new architecture to scale up to more EHRs and to lead to a sustainable platform (as will be discussed in a subsequent section of this paper). It was found that the approach to hosting educational EHRs on a centralized server mitigates the need for multiple sites or institutions to have to set up their own servers, removing complexity and cost for hosting and managing educational EHRs [1-3].

3. Development of a Portal and Access to Specific Electronic Health Records

Over the course of a lifetime, health professionals and health information technology professionals will work with many different EHRs and differing versions of the same EHR [1]. For these reasons, our work initially focused on identifying both open source and commercial EHRs that are typical in terms of the features and functions of those encountered in everyday work in differing health care settings [1]. This work began with identifying EHRs found to be the gold standard in design, function and ability to effect improved patient outcomes such as the Veteran's Affairs Vista system [1,5]. The Veteran's Affairs Vista system was identified as a core candidate EHR system for its user interface and fully functional decision support tools (e.g. drug-drug interaction checking) [1, 2, 5]. Followed by EHRs that have been developed for specific purposes such as a Pediatric EHR, a personal health record and a commonly utilized, and easily extensible, EHR – OpenMRS. Our choice of records was based on pedagogical reasons so that students would have the opportunity to engage with fully functional records [1]. Some students have limited exposure to EHRs in their training due to a lack of availability of an EHR in a classroom setting and/or the local regional health authority. Other students have access to a hybrid paper-electronic health record in their local health authority setting [3-6]. Here, the record may only provide access to specific components of a patient's record; for example, laboratory results, diagnostic imaging results, clinical documentation and medication information [6]. Some components of the EHR may be in the process of being implemented and may not be readily available such as ePrescribing and/or other decision support tools [6, 7]. For this reason, there is a need to provide students with the opportunity to access a fully operational EHR that has been successfully used and implemented [1]. In one pilot of this work, we provided access to OpenVista to nursing students as part of a classroom exercise. The students were provided access to OpenVista via the portal. Students were asked to interact with the record (that included artificial, simulated patient cases) and complete readings. Artificial patient cases (i.e. dummy data) were used so issues around patient privacy and

confidentiality did not arise. In class, a presentation was provided to students about the EHR and its use in a modern healthcare system. During a classroom exercise a case study approach involving student group work and faculty facilitation enabled students' to identify the benefits and challenges of using an EHR. Students' described the interaction between the technology's design, nurse's work and its influences on patient communication and care. Students adapted to the use of the EHR, identifying the need to be able to use the technology in the classroom and then the workplace setting [1, 4].

4. Development of an Educational EHR Simulator

In an extension of this work, we developed an EHR simulator. The simulator is a fully robust EHR that provides access to a real-world EHR with all the features, functions and decision support tools present in a typical EHR. Unlike a traditional EHR, the EHR simulator, afforded faculty the opportunity to incorporate simulated educational cases into the EHR that could be used to stimulate critical thinking and problem solving, much as would be done when a health professional was presented with information about a patient over time as laboratory and diagnostic test results are completed. Rather than reading a case, as was historically done in the context of a problem based medical curriculum, medical students were presented with an initial lecture and access to an EHR, where patient information was presented as would be typically provided during a typical hospital stay. During the course of a week, students were provided with additional information about the patient's condition in the form of diagnostic and laboratory test information as well as information provided through consult reports (much as information would be made available over time as tests are completed and results are provided). The information provided via the EHR was integrated with standard lectures about chronic illness and disease. Each day the instructor was able to discuss the patient case and information made available via the EHR with the students face to face in a classroom setting. Students were able to interact with the patient case via the EHR. Students were also able to prescribe medications, order laboratory and diagnostic tests, document patient information and interact with decision support tools to support medical decision making. The EHR afforded students and faculty the opportunity to interact via an EHR and to review students' decisions in the context of hypothetical patients' whose medical conditions evolve over the course of a week. Medical students participated in medical lectures and engaged with the EHR and a patient case – the EHR added a dynamic element to the medical decision-making component [8]. Students identified that the EHR could support physician work, and there was a need to test out several differing types of EHRs to determine their ability to fully interface with their own clinic workflows. The students' positively evaluated the technology's use in the classroom. The students rated the educational sessions highly and suggested that more classroom work be done on EHR integration into a medical office as well as critiquing the technology. Lastly, students wanted exposure to more than one EHR over the course of a 4-year medical curriculum to familiarize themselves with EHRs used provincially [9].

5. Loose versus Tight Coupling of EHRs in a Health Professional Curriculum

In the above two pilots, the authors discovered that introducing EHRs into a health professional curriculum, can be done on a continuum from "loose coupling" to "tight
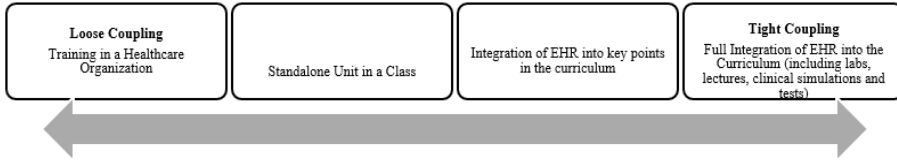
Figure 1. From loose to tight coupling.

coupling" (see Figure 1 below). In loose coupling curricular approaches, the EHR is introduced as a stand-alone artifact at differing points in time in a typical four year medical or nursing curriculum. The technology is used as an example of how the EHR can be used to support patient care. In a tight coupling curricular approach, the EHR is used to present materials in the context of a curriculum and becomes the dominant technology (much as the EHR is the primary tool used to support critical aspects of patient care). All patient teaching cases and links to educational materials and resources can be found in the EHR. The EHR becomes part of teaching in the classroom [10].

Both approaches have their advantages and disadvantages. The loosely coupled approach allows for student and faculty exploration of a technology or the integration of several differing technologies. Work must be done by instructors to determine how the technology can be used to illustrate concepts and content taught in the classroom. In a tight coupling approach the technology is a tool that the instructor and student use to educate and to acquire knowledge respectively; for example, the EHR becomes an educational tool and a tool that is used to support work [10].

6. Beyond the Electronic Health Record: Design, Development and Implementation

To date we have integrated EHRs into medical and nursing curricula using a tight and a loose coupling approach. Initially, our work focused on exposing students to the technology [10]. Then we focused on the technology as an educational tool that supports acquisition of medical and nursing knowledge as well as knowledge of the EHR [1]. We then turned our focus to the designers, implementers and innovators of health information technology tools.

Extending beyond this work, health informatics and health information technology students need to learn how to design, develop, implement and maintain health care technologies that are used by health professionals and by patients. Research was conducted at the School of Health Information Science that focused on training health information technology and health informatics professionals. Study results suggested that teaching students how to use an EHR in the classroom improved health informatics competency development and lead to the acquisition of competencies necessary for professional certification. Here, our work involving the portal went on to include the design, development and implementation of EHRs and those technologies that interface with EHRs. To illustrate, health informatics students may need to learn how to use an EHR in the first year of their studies, with their knowledge extending to an in-depth conceptual and technical understanding of the technology and how it can be designed, developed, implemented and integrated with other technologies to provide context sensitive patient care. Here, a student will learn about creating the databases that collect patient data, develop strategies for new innovations to interface with the EHR, learn how to extract data from EHRs, design new interfaces for new types of devices, and innovate

new technologies that go beyond the EHR (e.g. sensors) to support individuals in the community. The authors have also developed a model and approach based on this work at a curriculum level that can be used to inform decision-making regarding training of health informatics and health information technology professionals [11, 12].

7. Challenges, Recommendations and Lessons Learned for Educators

There are a number of challenges and needs for future work in this area. One of the key challenges is the development of a plan for sustaining the upkeep of the portal over time, as we have found this requires a fair amount of technical expertise. From our experience this requires educating decision makers in the educational and governmental hierarchies about the need to provide resources to support educational EHR initiatives over time, so they can continue into the future. From a technical perspective, modification of open source software to adapt to educational needs can be a challenge and the ease of doing this depends on the specific software. From a pedagogical perspective, unlike single vendor educational EHR products, which provide access to one type of system, portals provide access to varying types of EHRs so that students become familiar with varying systems and their use in clinical settings (which is important to address). As well, we had initially hoped that EHR vendors would donate their software to be hosted on our portal, but we have only recently begun to get commercial systems running for students.

There are challenges in the area of curriculum integration and how and when it is best to bring EHR education into medical, nursing and health informatics professional education. We have found a "training wheels" approach, where more advanced EHR features are hidden from students, may be useful during early parts of health professional education (as students' progress through their training on more advanced features can be made available). A further need is the development of authoring tools and interfaces to help educators both create cases for simulations (e.g. allowing simulated patient data to be easily input into the EHR by instructors) and to allow for adding comments, tips and quizzes embedded within key points in the educational EHR that support the development of discipline specific competencies. One approach we have experimented with is the inclusion of "info-buttons" that can be easily added to the user interface and that students can click on to receive context-sensitive advice and educational information as they work through cases using different EHRs. This may take the form of access to search tools such as PubMed [see 14] and there would be a need to extend this work to include lecture notes, videos and/or context specific information.

There is need to conduct further work regarding the level of access and integration of EHRs in medical, nursing and health informatics professional educational curricula that is necessary for health professionals to acquire EHR competencies. For example, physicians and nurses may only need to learn how to effectively use an EHR, reviewing only discipline specific information as individuals with differing disciplinary backgrounds attend to varying types of information to support their decision making [15]. In contrast health informatics and health information technology students will need to learn how to use an EHR, have exposures to differing types of EHRs, understand the underlying programming, develop EHR architectures, design user interfaces, develop interoperability structures, design databases and innovate new analytic methods for effectively extending and managing this technology (see [11]).

8. Discussion and Conclusions

Our work represents 10 years of research in the area of educational EHRs and their integration into medical, nursing and health informatics curricula. Technological and educational advancements have made it possible to provide hundreds of medical, nursing and health informatics students with access to an EHR portal that acts as a gateway to multiple differing open source electronic health records (including records developed to support the care of specific patient populations (e.g. children) and groups (patients who use personal health records) [1-4]. Yet, even as access to varying EHRs for health professionals is needed in a classroom setting, few health professional educational programs provide such access to EHRs and even fewer integrate the technology effectively into teaching using a tight coupling approach. Our work has shown that a portal approach where students can remotely access EHRs is ideal.

References

[1] E.M. Borycki, A.W. Kushniruk, R. Joe, B. Armstrong, T. Otto, K. Ho, et al., The University of Victoria Interdisciplinary Electronic Health Record Educational Portal, *Stud Health Technol Inform* **143** (2009), 49-54.

[2] B. Armstrong, A.W. Kushniruk, R. Joe, and E.M. Borycki Technical and architectural issues in deploying electronic health records (EHRs) over the WWW, *Stud Health Technol Inform* **143** (2009), 193-8.

[3] E.M. Borycki, R. Joe, B. Armstrong, P. Bellwood, and R. Campbell, Educating health professionals about the electronic health record (EHR): Removing the barriers to adoption through improved understanding. *Knowledge Management and E-Learning: An International Journal* **3** (2011), 51-62.

[4] E.M. Borycki N. Frisch, J. Moreau, and A.W. Kushniruk, Integration of electronic health records into nursing education: Issues, challenges and limitations, *Stud Health Technol Inform* **208** (2015), 88-92.

[5] S.H. Brown, M.J. Lincoln, P.J. Groen, and R.M. Kolodner, VistA—US department of veterans affairs national-scale HIS, *Int. J. Med. Inform* **69** (2003), 135-156.

[6] R. Collier, National physician survey: EMR use at 75%, *CMAJ* **187** (2015), E17-18.

[7] PrescribeIT Canada's electronic prescription service, (n.d.). https://prescribeit.ca/ (accessed May 31, 2019).

[8] R.S. Joe, A. Otto, and E.M. Borycki, Designing an electronic medical case simulator for health professional education, *Knowledge Management and E-Learning: An International Journal* **3** (2011), 63-71.

[9] A.W. Kushniruk, E.M. Borycki, R. Joe, T. Otto, B. Armstrong, and K. Ho. Integrating electronic health records into medical education: Considerations, challenges and future directions, in: K. Ho, S. Jarvis-Selinger, H. Novak Lauscher, J. Cordeiro, and R. Scott (Eds), *Technology Enabled Knowledge Translation for eHealth*, Springer, New York, 2012, 21-32.

[10] E.M. Borycki, A.W. Kushniruk, B. Armstrong, R. Joe, and T. Otto. Integrating electronic health records into health professional and health informatics education: A continuum of approaches, *Acta Informatica Medica* **18** (2010), 20-24.

[11] E.M. Borycki, J. Griffith, P. Reid, M. H. Kuo, and A.W. Kushniruk, Do electronic health records help undergraduate students develop health informatics competencies? *Stud Health Technol Inform* **205** (2014), 838-842.

[12] E.M. Borycki, J. Griffith, and A.W. Kushniruk, Integrating electronic health record competencies into undergraduate health informatics education, *Stud Health Technol Inform* **228** (2016), 634-7.

[13] A. Shachak, S. Elamrousy, E.M. Borycki, S. Domb, and A.W. Kushniruk, Towards educational electronic health records (EHRs): A design process for integrating EHRs, simulation and video tutorials, *Stud Health Technol Inform* **228** (2016), 624-8.

[14] J.J. Cimino, G. Elhanan, and Q. Zeng, Supporting infobuttons with terminological knowledge, in: *Proceedings of the AMIA annual fall symposium*, 528-532, 1997.

[15] E.M. Borycki, L. Lemieux-Charles, L. Nagle, and G. Eysenbach, Evaluating the impact of hybrid electronic-paper environments upon novice nurse information seeking, *Methods of Information in Medicine* 48 (2009), 137-143.