Medical Education in the Electronic Medical Record (EMR) Era: Benefits, Challenges, and Future Directions

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Abstract

In the last decade, electronic medical record (EMR) use in academic medical centers has increased. Although many have lauded the clinical and operational benefits of EMRs, few have considered the effect these systems have on medical education. The authors review what has been documented about the effect of EMR use on medical learners through the lens of the Accreditation Council for Graduate Medical Education's six core competencies for medical education. They examine acknowledged benefits and educational risks to use of EMRs, consider factors that promote their successful use when implemented in academic environments, and identify areas of future research and optimization of EMRs' role in medical education.

Both undergraduate and graduate medical education are undergoing significant transformation, partly reflecting the rapid evolution of technology in health care delivery.[1,2] Medical learners at both the graduate and undergraduate levels are increasingly required to use an electronic medical record (EMR) to manage patient care. Although use of the EMR has been shown to have numerous clinical benefits,[3–5] comparatively little is known about the effect this technology has on medical education, and few authors have attempted to review both the potential benefits and unintended consequences.[6,7]

Over a decade ago, the Accreditation Council for Graduate Medical Education (ACGME) introduced six domains of clinical competency, and more recently the ACGME began to restructure the graduate medical accreditation system to reflect educational outcomes of these competencies.[2] In this Perspective, we use the ACGME competencies (Medical Knowledge, Practice-Based Learning and Improvement, Patient Care, Communication Skills, Professionalism, and Systems-Based Practice) to review what is known about the effect of the EMR on achievement of these core competencies, and make recommendations for how educational institutions can leverage the EMR to support the achievement and measurement of these educational milestones and entrustable professional activities (EPAs).

Medical Knowledge and Practice-Based Learning and Improvement

With an ever-expanding body of biomedical literature, development of an adequate fund of medical knowledge is a mounting challenge for medical trainees. Clinical decision support (CDS) systems within the EMR have the potential to enhance trainees' fund of knowledge and to guide learning efforts. Point-of-care education accessed via CDS allows for easy access to relevant and up-to-date medical literature from which students and residents can draw to formulate diagnosis and management plans.[8] A thoughtfully implemented EMR can facilitate "just-in-time" education and can allow physicians to apply evidence-based medicine in the clinical context.[7] CDS can also provide opportunities to teach best practices by advising learners to take actions consistent with accepted clinical algorithms and recommendations.[9–14] Population management tracking and EMR-integrated clinical registries can also help teach learners important concepts in quality improvement.[6]

Despite the benefits of CDS, several authors have documented its unintended consequences, which may adversely affect medical education. An early review of CDS found that it was overwhelming and inappropriate to workflow and, thus, was underused and ineffective in practice.[15] More recent studies have shown that implementing an EMR with unmodified settings determined by the vendor can result in an unacceptably high volume of clinically insignificant alerts, thereby promoting alert fatigue.[16,17] Although refinements in technology have gradually increased the usefulness of these systems to medical learners,[18] and well-implemented CDS systems have been shown to yield positive educational outcomes for the learner's quality of clinical care,[13] there is still limited understanding of how CDS affects the acquisition of knowledge by trainees. Future research efforts should evaluate the influence of CDS not only on medical trainee behaviors but also on their underlying fund of knowledge.

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Further, the specific elements of CDS that most strongly affect both knowledge and behavior need to be elucidated.

Patient Care

EMRs affect how trainees learn to care for patients in a variety of ways, from shifting workflows to altering opportunities for critical clinical thinking. Optimizing trainee workflow is essential for protecting their time for patient interactions and educational activities. The EMR has the potential to positively affect medical trainee workflow through several different mechanisms, including reduced time spent in accessing medical histories, ease of data retrieval, greater remote access, and automated creation of sign-out documents to support handoff workflow.[6,19–21] However, detrimental effects of EMRs on the workflow have been documented secondary to inefficiencies in data entry, hardware downtime issues, and shifting of work from ancillary staff to physicians.[17,19,22]

With thoughtful planning, decision makers can ensure that the EMR favorably affects trainees' workflow by, for example, ensuring adequate and strategic placement of computer hardware, developing robust downtime procedures, and making key decisions about the most appropriate personnel to be responsible for various types of data entry. During the process of implementing the EMR, medical educators and program directors should be advocates for decisions that optimize trainee workflow.

EMRs can also optimize workflow for both individual trainees and training programs by facilitating the process of monitoring trainees' clinical experience. Graduate medical education is transitioning to an accreditation structure based on the achievement of outcomes detailed by educational milestones and EPAs.[23,24] To this end, the EMR can facilitate tracking and reporting of trainees' exposure to patient diagnoses and procedures. Reports of the trainees' clinical activity and review of their clinical notes via the EMR can provide written documentation of the trainees' achievement of patient care milestones and EPAs and can help identify areas of deficiency more efficiently than in a paper-based system.[25,26]

Although improved workflows have the potential to increase opportunities for trainees to engage in critical clinical thinking, some medical educators have noted concern that the EMR may negatively affect development of critical thinking skills.[27,28] Few studies examine how standardized order sets, CDS error-checking interventions, and prepopulated notes in the EMR may affect the development of critical thinking and clinical decision-making skills. In a recent study comparing medical students in computerized provider order entry (CPOE) environments with those in paper-based environments, Knight and colleagues[29] found no significant differences in self-reported quality of admission orders, but more rigorous and objective measures are needed to determine the true effect of CPOE with CDS on trainees' decision making and ordering.

An additional factor that may negatively affect the self-directed learning efforts of trainees is automation bias. Previously described in the aviation industry, automation bias refers to overreliance on automated systems leading to complacency of clinicians in evaluating their own decisions.[30] For example, if trainees feel like the EMR system will alert them of potential serious side effects or drug interactions, they may be less likely to research these possibilities before ordering a medication. Further research is needed to delineate how the tools provided by the EMR contribute to the development of automation bias and affect the development of critical clinical thinking and medical decision making in trainees.

Communication Skills

EMRs have the potential either to enhance or impair the development of effective written communication skills, which medical students are expected to begin developing during undergraduate medical education. However, in some settings medical students are prohibited from adding clinical documentation to the EMR.[31] Moreover, using note templates and copy-and-paste capabilities in charting dramatically decrease the effectiveness of physician notes as a communication tool.[7,32,33] Some authors have suggested that this issue not only degrades the accuracy and utility of the clinical care record but may also impair the development of critical reasoning skills by medical learners and reduce the amount of original charting available for attending feedback.[7,31,34]

Strategies for mitigating some of the concerns associated with allowing trainees to contribute clinical documentation to the EMR include the creation of customized note templates for medical learners. Such templates may contain more free-text fields, minimize auto-fill and auto-text options, and prompt the documentation of certain features, such as a problem list or differential diagnosis, thereby actually promoting critical thinking.[35,36] Stephens and colleagues[37] have proposed a specific educational approach to clinical documentation called the Reporter–Interpreter–Manager–Educator (RIME)/EMR scheme, which structures the introduction, expectations, and assessment of EMR skills throughout the medical education process.

EMRs may also affect the development of oral presentation and communication skills. Traditionally, details of the patient's history and clinical status were transmitted from the presenting trainee to the team during rounds. In a highly automated patient care setting, attending physicians may be more likely to receive their patient information in advance of rounds and may no longer rely on or engage trainees during case presentations.[37] Peled and colleagues[7] argue that this shift impairs the trainee's practice of translating and synthesizing clinical information both before and during rounds. Furthermore, if the attending has already viewed the data and formulated a plan independently, the benefits of intellectual exchange and modeling clinical decision making during the rounding process may be lost. Despite these concerns, others might argue that with raw data more readily available, learners can spend more time synthesizing, rather than gathering, information, as well as demonstrating clinical reasoning in real time. Likewise, the EMR can be used as a tool for answering clinical questions that arise during rounds, allowing the active demonstration of the manager/educator skills emphasized in frameworks like the RIME/EMR scheme.[37]

Future research and curricular development should focus on formalizing EMR-specific written and oral communication competencies by training level and integrating them into the education and evaluation of medical learners. In addition, national educational organizations can help academic medical centers with best practice guidelines for integration of medical learners into EMR environments.

Professionalism

As EMR implementation reshapes the way that physicians interact with their patients and with other medical professionals, new issues arise for fostering the development of professionalism in trainees. Many clinicians have expressed concern over reduction in the quality of patient–learner interaction. Verghese et al[38,39] eloquently described the "iPatient" who has been evaluated, diagnosed, and treated at the computer screen alone prior to bedside examination and is the product of an informal, unintended curriculum in academic settings. Furthermore, some studies show that both residents and medical students perceived a decrease in patient–physician interaction when learning in an EMR-based outpatient clinic.[19,40] In spite of these concerns, others suggest that provider experience and facility with the EMR can improve the physician–patient interaction,[40–42] and a lack of computer navigation skills may contribute to limited provider–patient communication.[41] Indeed, Peled and colleagues[7] suggest that learners should begin developing EMR-specific skills for patient encounters early in their educational process, and Morrow and colleagues[43] showed that medical students within their first year of training can demonstrate EMR-specific communication skills after a brief educational intervention. Further research and curricular development are clearly needed to determine how and when EMR-specific skills for the patient encounter should be introduced to medical learners.

Systems-Based Practice

Within the ACGME framework of core competencies, systems-based practice refers not only to the use and optimization of the entire health care system in caring for patients but also to teamwork within that system. Comprehensive EMR systems can educate all medical learners to appreciate the complexity of the care provider network required to provide a medical home.[44] Use of the EMR can also lead to significant educational yield from the review of outcomes of populations under care. Importantly, population health management has received select emphasis in the Meaningful Use criteria, which propose generation of lists by specific medical conditions to be used for quality improvement, research, outreach, and reduction of disparities.[45]

The concept of systems-based practice also encompasses cost-effective care for populations. To this end, integration of cost information in CPOE systems can clearly influence physician-ordering behavior.[46] Influential thought leaders have recently described the fundamental properties of a highly participatory, rapid-learning health care system—one that is agile and flexible and can provide learners with feedback—that can be developed in part from the meaningful use of electronic health records,[47] but

Table 1

Key Issues of Electronic Medical Record (EMR) Use for Accreditation Council for Graduate Medical Education Core Competencies

Core competency	Benefits	Challenges	Future directions
Medical Knowledge	Point-of-care clinical decision support (CDS) allows for context-relevant education[7]	Volume of online information may be overwhelming or underused[15]	Assess impact of CDS on fund of knowledge and identify most useful elements of CDS for learners
Practice-Based Learning and Improvement	• CDS provides opportunities to teach students and residents best practices[7] • EMRs offer opportunities in research and quality improvement education[6]	• CDS may be inappropriate to workflow, and/or promote alert fatigue[15] • Functional tools for registry tracking are still nascent[44]	• Well-planned implementation of CDS may improve teaching opportunities • Further development of patient-tracking tools will allow greater use in quality improvement
Patient Care	EMRs can reduce time spent in data gathering[6,19] and allow for efficient profiling and tracking of trainee clinical experiences and milestones[6]	EMRs may also introduce workflow inefficiencies[17,19,22] and may dull or stunt critical thinking skills[27,28]	Evaluate optimal computerized provider order entry implementation to maximize workflow efficiencies, and preserve critical clinical thinking
Interpersonal Skills and Communication	Learners may spend less time gathering and more time synthesizing clinical data[6,19]	Restrictions imposed on use of order entry or charting may limit EMR skill acquisition and documentation proficiency[31]	Modify documentation systems to promote EMR usage by trainees. Evaluate use of EMR as a tool for mobile, real-time clinical presentations.
Professionalism	Dedicated computer skill teaching can improve patient–provider interaction[43]	Computer–provider interaction may displace or degrade provider–patient interaction[19,40]	Determine how and when EMR-specific patient encounter skills should be introduced and assessed
Systems-Based Practice	EMRs offer potential for teaching effective integration of a network of care providers[44,47]	EMR systems have not reached maturity to support full multidisciplinary collaboration[44]	EMR technology needs to advance to fulfill needs of learners to operate effectively in the realm of the patient-centered medical home

these processes are challenged by the use of multiple electronic systems across different venues of care that do not seamlessly interoperate. In fact, Bates and Bitton[44] concluded that two of the least developed areas of current EMR systems are support for team-based care and integrated registry analytics. As EMR systems continue to evolve, future innovations in collaborative technologies may allow for enhanced opportunities for medical learners to meet educational goals in systems-based practice.

Leveraging the EMR for the Optimal Educational Experience

In this first review of the effect of the EMR on medical learners, using the ACGME core competency structure, we have discussed many factors that affect all six domains. Best practices for integrating the EMR in medical education are beginning to emerge in the literature, and future directions for study are materializing (see Table 1). For example, during EMR implementation, medical educators should advocate for design features that optimize trainee workflow. Medical educators can and should take an active role in shaping hospital CDS interventions that support educational goals without overwhelming trainees and contributing to alert fatigue. If the technology supports it, educators should use automatic reports from EMRs to track trainees' experience with various diagnoses and procedures.

Leaders in clinical informatics have proposed that the EMR has the potential to unlock methods of teaching on even grander scales that have not yet been possible. Future iterations may foster achievement of a nationwide "learning" health system which supports the use of large networks[48,49] and the integration of local systems into a national or even global construct to ultimately promote effective medical education and patient care.[47]

As other aspects of industry and society embrace information technology, patient care and medical education have been uniquely enhanced—and challenged—by the transition from paper-based medical records to EMR-based tools. Certainly, the EMR is among the most significant changes to health care practice in the 21st century, and it has been met with both enthusiasm and healthy skepticism. As educators strive to transition medical trainees into lifelong learners, everything we have described is equally applicable to continuing medical education. We believe appropriate use of the EMR and related technologies in medicine can offer clinical educators and trainees a rich and promising platform to use in pursuit of a positive and effective educational experience.

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