Primary Care Physicians' Use of an Electronic Medical Record System: A Cognitive Task Analysis

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OBJECTIVE: To describe physicians' patterns of using an Electronic Medical Record (EMR) system; to reveal the underlying cognitive elements involved in EMR use, possible resulting errors, and influences on patient-doctor communication; to gain insight into the role of expertise in incorporating EMRs into clinical practice in general and communicative behavior in particular.

DESIGN: Cognitive task analysis using semi-structured interviews and field observations.

PARTICIPANTS: Twenty-five primary care physicians from the northern district of the largest health maintenance organization (HMO) in Israel.

RESULTS: The comprehensiveness, organization, and readability of data in the EMR system reduced physicians' need to recall information from memory and the difficulty of reading handwriting. Physicians perceived EMR use as reducing the cognitive load associated with clinical tasks. Automaticity of EMR use contributed to efficiency, but sometimes resulted in errors, such as the selection of incorrect medication or the input of data into the wrong patient's chart. EMR use interfered with patient-doctor communication. The main strategy for overcoming this problem involved separating EMR use from time spent communicating with patients. Computer mastery and enhanced physicians' communication skills also helped.

CONCLUSIONS: There is a fine balance between the benefits and risks of EMR use. Automaticity, especially in combination with interruptions, emerged as the main cognitive factor contributing to errors. EMR use had a negative influence on communication, a problem that can be partially addressed by improving the spatial organization of physicians' offices and by enhancing physicians' computer and communication skills.

KEY WORDS: Electronic Medical Record (EMR); primary care physician; cognitive task analysis.

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INTRODUCTION

The motivation to use computerized information systems in health care is driven by expectations that such systems will improve the quality of care, increase patient safety, and lower medical costs.¹ In a recent systematic review of 257 papers, Chaudhry et al. reported that preventive care was the primary domain of quality improvement associated with Electronic Medical Record (EMR) use. The principal benefits were increased adherence to guidelines, enhanced surveillance and monitoring, and decreased medication errors. The major efficiency benefit was decreased utilization of care.²

Despite these apparent benefits, studies also suggest that the use of computerized medical information systems is limited to certain tasks or functions.^{3,4} Differences in knowledge, operating skills, satisfaction, and usage levels among users impede improvement of care quality.⁵ A number of studies point to unintended and sometimes adverse consequences of computerized medical information systems such as EMR or Computerized Provider Order Entry (CPOE). Patel et al.⁶ suggest that while paper records have a narrative structure, EMRs are organized into discrete data items. This difference can affect physicians' information gathering and reasoning strategies and thereby lead to information loss. Campbell et al.⁷ suggest nine categories of adverse unintended consequences associated with CPOE systems, including more or new work for clinicians, changes in clinicians' workflow and communication patterns, and new types of errors. Possible implications include medication errors, orders not being carried out,⁸ and increased mortality rates.⁹

Computerized medical information systems have the potential to help physicians and patients share information, thereby educating and empowering both.^{10,11} While interpersonal and communication skills are acknowledged as key components of clinical competence,^{12,13} the effects of EMR use on the patient-physician relationship is just beginning to be understood. Our literature review¹⁴ suggested that EMR use has an overall positive influence on the exchange of medical information,

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including questions about therapeutic regimens, and patients' disclosure of medical information.¹⁵ Physicians who used EMRs accomplished information-related tasks—such as checking and clarifying information, encouraging patients to ask questions, and ensuring completeness at the end of patients' visits—to a greater extent than did physicians who used paper records.¹⁶

The literature review also revealed, however, that EMR use often had a negative impact on patient-centeredness. For example, at the outset of patient visits physicians commonly walked straight to their computer monitors after only a short greeting.¹⁷ Physicians' screen gaze averaged about one quarter of the time they spent with their patients and was inversely related to their psychosocial questioning and emotional responsiveness.¹⁵ Further, computer use often caused physicians to lose rapport with their patients.^{15,16,18,19} It has been proposed that physicians' behavioral style, computer and communication skills, as well as their experience, affect patient–doctor communication in the context of EMR use.^{20,21}

In order to understand better the effects of computerized information systems on patient safety and quality of care, it is important to comprehend how physicians actually use them. The purpose of this study was to conduct an in-depth analysis of primary care physicians' use of an EMR system, focusing in particular on errors associated with EMR use and its impact on patient–doctor communication.

THEORETICAL BACKGROUND

Cognitive science offers four useful conceptual frameworks to gain deeper insight into physicians' use of EMRs: cognitive load, attention, automaticity, and expertise.

Cognitive Load

Cognitive load refers to the extent to which cognitive resources, especially working memory, are utilized during learning, problem solving, thinking, and reasoning.²² Research on human memory has demonstrated that, in contrast to long-term memory, which is practically unlimited, working memory has a limited information storage capacity and is fragile—that is, distractions can easily cause forgetting.^{23,24} A high working memory load may result from the kind and amount of new information (extraneous cognitive load) and the complexity of information (intrinsic cognitive load), and it may interfere with other cognitive processes and clinical performance.²⁵

Attention

Attention is described in various ways, including the ability to focus on a task, concentrate, and allocate processing resources to a specific source of information while ignoring others. Two of the common metaphors for attention are a filter, which blocks irrelevant information, or a spotlight, which illuminates specific information.²⁶ Cognitive psychology distinguishes between focused attention, which is the processing of a single input, and divided attention, which is the simultaneous processing of multiple signals. Dual task performance improves with practice, but is negatively affected by task similarity and task difficulty.²⁴

Automaticity

Automaticity describes skilled performance that requires little conscious attention. It is developed through repetition. Because they require little guidance or monitoring, automatic actions are fast and efficient.²⁷ However, when actions that require attention become habitual, automaticity can lead to errors.^{28–30}

Expertise

The Dreyfus Model of Skill Acquisition³¹ suggests that people pass through five stages in the process of developing expertise. These stages are: novice, advanced beginner, competent, proficient, and expert. Benner demonstrated that while moving through these five stages, nurses' recognition of clinical situations shifted from relying on abstract principles to an experience-based intuitive grasp of the situation.³² Other characteristics that distinguish experts from novices include the ability to quickly discern a big picture rather than isolated pieces of information, use of "job smarts" to work more efficiently, and self-monitoring of performance.³³

OBJECTIVES

A cognitive task analysis (CTA, Appendix A) of primary care physicians' use of an EMR system was conducted, with the following objectives:

1. To investigate and describe physicians' patterns of EMR use
2. To study how EMR use influences patient–doctor communication
3. To reveal the underlying cognitive elements involved in EMR use, possible resulting errors, and influences on patient–doctor communication.
4. To gain insight into the role of expertise in incorporating EMR use into clinical practice in general and communicative behavior in particular.

METHODS

Setting, Population, and Sample

The research was conducted at Clalit Health Services (aka Clalit), which, with 3.7 million members, is Israel's largest health maintenance organization (HMO). Primary care physicians were selected as the population to study because of their heavy EMR use. To date, nearly 100% of primary care physicians in Israel use EMR systems, with the two largest HMOs, which serve approximately 70% of the country's population, using the same commercial system, Clicks@.³⁴ EMRs have been used at Clalit since 1993.

From May 2006 to August 2007, 25 primary care physicians participated in the study. In the first stage we approached six family physicians, pre-identified as subject matter experts, i.e., accredited family physicians with 10 or more years of clinical and EMR experience. All six pre-identified experts consented to participate and were interviewed. Next, five primary care clinics from Clalit's northern district were chosen. Selection

criteria included clinic size, urban and rural settings, and patients' socioeconomic profiles. Fourteen physicians from these clinics who had agreed to participate (70% response rate) were interviewed. In the next stage, theoretical sampling³⁵ was employed to recruit five additional study participants. Specifically, pediatricians and residents were sought in an attempt to account for the influence of medical specialty and experience. Finally, purposeful sampling was undertaken to select five physicians for observation (from among all the study participants) who represented different specialties (family medicine and pediatrics), years of clinical experience, and levels of computer skills. Data collection continued until theoretical saturation³⁵ was reached.

The ethics committee of Meir Medical Center, Kfar-Saba, Israel (in charge of ambulatory research for Clalit), approved the study. We obtained informed consent from all participants.

Data Collection

Interviews. Two of the authors, AS and MH-D, independently conducted semi-structured interviews using an interview protocol adapted from Millitelo and Hutton³³ (Appendix B). All but four of the interviews were held in the physicians' offices. Participants were encouraged to use their EMRs for demonstration purposes. Interviews were audio recorded, transcribed verbatim, and analyzed.

Observations. AS observed five primary care physicians during 69 patient-physician encounters in June and July 2007. Physicians' use of their computers was noted, with special attention paid to errors and potentially risky actions (identified, in part, by interview analysis) as well as encounter management and communication patterns. The amount of time physicians spent communicating with patients, screen gazing, typing, and dealing with interruptions was recorded.

Data Analysis

Data were analyzed using a combination of grounded theory³⁵ and ACTA³³ approaches. AS and MH-D independently scrutinized interview transcripts and observation summaries to familiarize themselves with the data, which were then open coded and categorized. Initial agreement between researchers was high (83% on themes), and open discussions were held until consensus was reached. Relationships between categories were then determined using axial coding.³⁵ Analysis began as soon as data were accumulated, and the results of initial data analysis shaped further data collection and analysis (e.g., by modifications to the interview and observation protocols and theoretical sampling). Finally, a task diagram was drawn and a knowledge audit table developed.³³

RESULTS

Descriptive Statistics

Descriptive statistics of the study participants appear in Table 1. Participants had an average of 12.3 years of medical work experience and 6.8 years of EMR experience. As expected, subject matter experts had the longest clinical and EMR experience, while residents had the shortest. Participants

Table 1. Descriptive Statistics of the Study Participants

Group	N	Female	Years since medical school graduation (mean $\pm$ SD)	EMR experience (years; mean $\pm$ SD)
Pre-identified SMEs	6	3	18.5 $\pm$ 5.9	11.0 $\pm$ 1.3
Family physicians	10	8	12.1 $\pm$ 5.7	7.2 $\pm$ 2.7
Pediatricians	3	0	14.7 $\pm$ 6.1	8.0 $\pm$ 2.6
General practitioners	1	0	11	2
Residents	5	3	3.9 $\pm$ 1.7	1.2 $\pm$ 0.8
Total	25	14	12.3 $\pm$ 7.3	6.8 $\pm$ 4.0

SMEs, subject matter experts

were not asked directly for their ages. However, a previous study of a similar population³⁶ has shown that age and time since being graduated from medical school are highly correlated.

EMRs and Cognitive Load

Study participants reported that clinical tasks such as diagnosing, reasoning, and treating severe or multiple medical conditions imposed the highest cognitive loads. Overall, study participants felt the EMR system reduced their cognitive loads. They were satisfied with the EMR system, especially with its data-related comprehensiveness, organization, and readability. They also appreciated that it made reviewing patients' medical histories and test results easier (Table 2). These aspects minimized the need to recall information from memory and eliminated the difficulty of reading handwriting. To some extent the EMR system also provided clinical decision aids. Physicians considered the system simple to use, and even those who had been using it for only 3–5 months reported completing many actions automatically (Table 2). Researchers' observations confirmed this view, with study participants quickly and nearly automatically performing system-related actions such as opening and closing charts, navigating between fields, and selecting items from lists.

EMRs and Perceptions of Patient Safety

EMR use exerted both positive and negative impacts on patient safety. On the positive side, physicians reported a reduction of their cognitive loads. They also said that the system's decision-making aids improved the quality of patient care. These as well as other features of the EMR system—such as alerts of potential adverse drug interactions—were perceived to enhance patient safety.

On the negative side, EMR use provoked new types of medical errors. Typical errors reported by most study participants (>60%) were typos, adding information to the wrong patient's chart, and unintentionally selecting an erroneous item (diagnosis or medication) from a scroll-down list located above or below the desired item (Table 2). Study participants described two common scenarios for adding to the wrong chart. The first arose when they opened a chart by typing a patient's name instead of using his or her unique magnetic card provided by the HMO. Typing in a patient's name opened a list of patients, and physicians sometimes accidentally

Table 2. Main Findings and Supportive Sample Quotations

Quality of care component	Patient safety		Patient-doctor communication	
	Findings	Sample quotes	Findings	Sample quotes
Cognitive load	<p>"The clinical tasks pose highest cognitive load."</p> <p>"Readability, organization, and comprehensiveness of information, the ability to easily review patient history, medication history, etc., reduce cognitive load and to some extent assists clinical decision making."</p>	<p>"Reaching a diagnosis and deciding on a treatment plan are the hardest parts."</p> <p>"I can find out in seconds if the patient has taken a vaccination ... whether I asked about smoking ... when she last took a mammography test, etc."</p>		
Automaticity	<p>"Automaticity creates new types of errors (especially in combination with interruptions)."</p>	<p>"Selecting medications from a drop down list is sometimes too automatic. You can easily make mistakes."</p> <p>A patient called to check something, so I opened his chart. When I returned to the visiting patient I forgot to close the new chart and continued writing in it instantly."</p>		
Attention			<p>"Both communication and EMR require focused attention. Multitasking is very difficult."</p>	<p>"The computer interferes with communication, no doubt. At least half of the visit my attention is to the screen and not to the patient."</p>
Elements of expertise	<p>"Some job smarts and EMR skills make work more efficient, but may also induce errors due to automaticity, memory lapses, etc."</p>	<p>"When a patient returns [with the same problem] I simply click the 'repeating visit' button to copy the previous visit and make changes to it."</p> <p>"I use templates when I have no time to type in data, but I don't like it. Pressing Enter, Enter, Enter is a prescription for errors."</p>	<p>"The negative impact of EMR on communication can be overcome by strategies, computer skills, communication skills, and job smarts."</p>	<p>"I try to listen first and then work with the EMR... to separate computer work from communication."</p> <p>"I only need very short breaks for typing because I know a lot of keyboard shortcuts."</p> <p>"I prepared standard templates for physical examinations, and I know many keyboard shortcuts. It's very fast and therefore allows me to dedicate more time to the patient."</p> <p>"I sometimes decide not to write in order to preserve a moment of intimacy."</p> <p>"I type the physical examination while the patient dresses."</p> <p>"I read out loud when I type and my patients react to it. They often correct me or provide more information."</p>

selected the incorrect individual. Some of the more experienced physicians reported knowing most of their patients by name. To save time, they reported, they would open such a person's chart as soon as he or she entered the office and glance at the record before beginning the clinical interview. The second reported scenario arose when, in response to an interruption (e.g., a nurse asking about another patient or taking a telephone call from a patient), a physician would open another patient's chart, forget to close it, and then type into it information about the visiting patient.

The study found that pharmacists often were the last safeguards against EMR-related errors. A number of study participants reported discovering they had written in the wrong patient's chart only after a pharmacist alerted them that the name on a prescription differed from the presenting patient's name (in Israel, paper prescriptions are mandatory even when generated by an EMR system). Similarly, study participants sometimes realized they had prescribed the wrong medication when concerned pharmacists asked whether they really had intended to prescribe a particular drug.

The findings indicate that study participants were aware of these potential errors. In all the cases observed, study participants reviewed printed prescriptions before signing and handing them to their patients. In several instances, study participants opened second charts as a result of interruptions; however, they always closed those charts before returning to their visiting patients. The only actual error that had been observed was a typo: a study participant had intended to write a letter confirming that a patient could exercise in a gym, but he instead wrote "can NOT exercise."

EMRs and Patient-Doctor Communication

Of the study participants, 92% felt EMR use disturbed communication with their patients. Two physicians argued that "multitasking is not a problem" and that "those who say the computer interferes with communication simply have a communication problem." Observational data indicate that physicians' average screen gaze lasted from 25% to 55% of the visit time.

The physicians who participated in the study were able partially to overcome the negative impact of EMRs on communication by using various strategies and enabling factors. The main strategy entailed separating EMR use from time spent communicating with patients (Fig. 1). Seventeen study participants reported the same encounter stages, although the sequence of events sometimes varied among physicians. During our observations we did not detect well-defined patient-visit stages. However, a clear separation between time spent inputting data into EMRs and time spent consulting with patients was noted. With one exception, physicians maintained eye contact with their patients and turned away from the computers. Most also did not touch their keyboards during conversations with their patients.

Physicians reported several communication-enabling factors in EMR settings. Computer skills, especially blind typing and the use of keyboard shortcuts and templates, reduced the burden of typing and, therefore, allowed more time for communication (Table 2). One of the observed pediatricians used a predefined template for all physical examinations. Prior to an examination he would type a keyboard shortcut to insert the template and then, while the patient settled down after the examination, he would alter the data based on his findings. One study participant commented that a concern for patient safety led her to prefer typing over using templates; in her view, "Pressing Enter, Enter, Enter is a prescription for errors."

Spatial organization of physicians' offices also supported patient-doctor communication. Two typical models were observed or reported (Fig. 2). In neither organization did the monitor interfere with eye contact. Three study physicians who employed the patient-centered model reported that this spatial organization

often facilitated comments from patients, corrections, and greater information exchange.

Finally, study participants' communication skills were another enabling factor that reduced the negative impact of EMR use on communication. The most influential skills observed were reading aloud while typing, maintaining eye contact, using body language to show attention and empathy, using humor to reduce tension, and leaving the computer completely and turning to the patient when conveying important information or discussing sensitive issues. However, in the 69 observed encounters only once did a study participant use the computer for patient education, i.e., to calculate a Framingham score using online software and to explain how a healthy lifestyle could reduce the risk of coronary heart disease.

Elements of Expertise

In the previous sections, a number of observed and reported elements of expertise were identified (Table 2). Ensuring documentation comprehensiveness was another element of expertise the majority of study participants noted. They usually achieved this element by typing data into their EMR systems; however, two study participants reported preparing comprehensive templates for common problems or examinations and using them as checklists to ensure anamnesis completeness. Elements of expertise appeared to be individual rather than related to physician accreditation, formal educational stage, or years of experience.

DISCUSSION

Numerous stakeholders are investing significant time and effort in promoting adoption of EMRs and other medical information systems, especially in primary care. This policy has recently been challenged by critics who argue that there is a need to improve the quality of EMR systems.³⁷ In line with such arguments, Walker et al. have recently questioned the contribution of EMRs to patient safety,³⁸ and a growing literature has pointed to the unintended adverse consequences of CPOE implementation. In this study these issues were examined at a micro level, focusing on the single physician and the clinical encounter as the unit of analysis. Our findings reveal the fine balance between the benefits and risks of EMR use.

Previous studies have noted that CPOE and EMR systems do not fully support many tasks, thus increasing cognitive load and requiring users to adapt their information management strategies to the new technology.^{39,40} In contrast, findings from the present study suggest that EMR use reduced physicians'

Figure 1. A typical sequence of a patient visit as described by study participants. Patient-centered stages are separated from EMR-centered stages (black). *Optional stage.

Figure 2. Typical spatial arrangements of physicians' offices.

cognitive loads associated with more demanding clinical tasks. This beneficial result arose as a result of data availability, readability, and organization, as well as, to some extent, decision support. Rather than cognitive load, automaticity—especially in combination with interruptions—was the main cognitive process contributing to EMR-related errors, such as adding to the wrong chart or selecting the wrong medication. In this regard, EMRs are no different from other human-machine systems. The literature is replete with descriptions of automaticity-related errors as well as observations on the potential role of interruptions in causing medical errors.^{29,30,41,42} Errors due to automaticity are often typical of experts rather than novices.²⁹ The difference between our findings and those of other studies of computerized medical information systems may therefore be due to the long period of EMR use at Clalit and users' generally high level of expertise.

Israeli law requires primary care physicians to print and physically hand prescriptions to their patients. While problems associated with paper persistence have been included in CPOE systems' adverse unintended consequences,⁷ the present study found that prescription printouts often served as a safety mechanism by providing physicians with a second chance to review prescriptions before signing them and by allowing pharmacists to compare the printouts with the patient data on their computerized systems. When moving to fully electronic prescriptions, it is essential either to maintain such safety mechanisms or to establish new ones. To that end, it is important to understand and redesign the workflow of the patient care process at a systematic, multi-professional level. That goal was beyond the scope of this study and should be further explored in future research.

Another example of the fine balance between benefits and risks in EMR use is the application of templates and keyboard shortcuts. On one hand, these features contributed to efficiency by enabling quick insertion of long text, thus allowing more time for communication. Occasionally, the study participants who were interviewed used comprehensive predesigned templates as checklists or assistance with diagnosis and treatment. However, one participant commented that the automaticity associated with shortcuts and templates could induce errors. Similar concerns have been expressed in a recent viewpoint article³⁷ and reflected in a study that found a steep rate of high risk copying and pasting of examination data.⁴³

Attention is another factor that plays an important role in EMR-supported clinical encounters. Our analysis suggests that physician multitasking is difficult and that both patients and EMR

systems require physicians' focused attention. This conclusion is consistent with the majority of previous studies, which report that EMRs have a positive impact on information exchange but that they often negatively affect patient-centeredness.

Some previous research has suggested that patient-doctor communication in EMR settings varies depending on physician style, experience, and baseline communication skills.^{18,20,21,45} In the present study, we were unable to identify different behavioral styles, perhaps due to the small number of observed study participants and the limitations of this methodology compared to the videotaped-encounter method others have employed. EMR experience did not seem to affect physicians' communication abilities. Rather, elements of expertise were individual and not dependent on formal accreditation or experience.

This study identified a number of strategies and enabling factors that reduced the negative impact of EMR use on communication. The main strategy was to divide encounters into distinct EMR- and patient-focused stages. Other strategies and enabling factors were spatial organization of the office, blind typing, computer navigation, and communication skills. These findings, too, are consistent with the literature.^{16,17,44–46}

IMPLICATIONS

We propose two complementary avenues to address the problems discussed in this paper: user-centered design and education. Some of the problems uncovered in this study may be system-specific. Others are common to many computerized medical information systems and devices. Computerized systems are often evaluated and sometimes certified for functionality and interoperability.⁴⁷ Generally, however, there are few requirements for high usability standards. Employing principles of user-centered design, usability inspection, and usability testing in simulated or real-life contexts might improve the quality of EMR systems and reduce the risk of EMR-related errors.⁴⁸

To date, EMR implementation and training usually focus on technological aspects, such as the functionality and capabilities of systems. The present study suggests it is important to go beyond these technical aspects of using EMR systems to a broader view of the benefits, risks, and principles of high-quality use during patient visits. The fine line between benefits and problems associated with EMR use, as well as the fact that more experienced users may be prone to EMR-related errors, further implies that clinicians should be educated about the use of EMR, not just on the job, but at all levels of their training—from basic medical education to residency to continuing medical education. Clearly, findings of this and other studies could pave the way to the development of such educational interventions. Many of the challenges, best practices, and elements of expertise identified would provide physicians with a broad set of tools and strategies that may be employed flexibly during consultation. As a result of this study, a simulation-based training intervention to qualify Family Medicine residents in better use of the EMR is being developed at MSR- Israel Center for Medical Simulation and will be evaluated in a follow-up research.

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Conflict of Interest: Shmuel Reis was a consultant for GMN (PHR provider) until August 2006. Roshtov, an EMR vendor, provided their platform (which is used by our study participants) for the research team to examine during the development of the research protocol and analysis of findings. We do not see any financial implications for these companies from this publication.

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APPENDIX A: COGNITIVE TASK ANALYSIS (CTA)

CTA is a methodology for characterizing and describing the cognitive elements underlying goal generation, decision-making, reasoning, and information processing. It also permits the identification of the role of expertise in performing complex tasks.^{33,49,50} Typically, CTA involves interviews, or a combination of interviews and observations, with six to eight Subject Matter Experts (SMEs). In the present study a specific variant of CTA was employed—Applied Cognitive Task Analysis (ACTA)³³—with some modifications. The CTA involved a combination of semi-structured interviews and direct observations that we then used to create a task diagram, identify potential errors, and study the effects of EMR use on patient–doctor communication.

APPENDIX B: INTERVIEW QUESTIONS

Adapted from Militello and Hutton³².

1. Background details

- a. Demographics: gender, specialty, years since graduation of medical school, time since finishing residency (for residents: stage of residency).
- b. Observe the spatial organization of the doctor's office: where do the doctor and patient sit? Where are the computer and the screen? Is the screen constant or mobile?

- c. Please define your level of experience in using the EMR (if the interviewee has difficulty answering this question offer a scale: non-user, novice, experienced user, expert user?). How long have you been using the EMR?

2. Task diagram

- a. Please describe the main stages of a typical patient visit and how you use the EMR in it? (The purpose is to get a broad picture of the visit, without getting into too many details. You may ask the physician to demonstrate how s/he uses the EMR.)
- b. Of the steps you have just identified, which require difficult cognitive skills? By cognitive skills I mean judgments, assessments, problem solving skills, etc.
- c. If the interviewee does not refer to these issues, use probes like: Which stages especially require consciousness and attention? Which actions are done automatically? At what stages have you made errors in the past? Can you give an example? At which stages have you paid close attention to communication with the patient?

3. Knowledge audit

- a. Experienced/expert users: what advice would you have for a resident who just started working with the EMR? OR
- b. Resident/novice users: What advice can you give others about using the EMR?
- c. During the time you have been working with the EMR, are there ways of working smart or accomplishing more with less that you have found especially useful?
- d. Can you think of a time when you realized you would have to change the way you were working with the EMR? *Follow-up probes:* to avoid medical errors? To improve communication with patients?
- e. Were there times when you had to rely on experience to avoid being led astray by the EMR? Probe: can you give me an example?
- f. Would you like to add anything?