You and me and the computer makes three: variations in exam room use of the electronic health record

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ABSTRACT
Challenges persist on how to effectively integrate the electronic health record (EHR) into patient visits and clinical workflow, while maintaining patient-centered care. Our goal was to identify variations in, barriers to, and facilitators of the use of the US Department of Veterans Affairs (VA) EHR in ambulatory care workflow in order better to understand how to integrate the EHR into clinical work. We observed and interviewed 20 ambulatory care providers across three geographically distinct VA medical centers. Analysis revealed several variations in, associated barriers to, and facilitators of EHR use corresponding to different units of analysis: computer interface, team coordination/workflow, and organizational. We discuss our findings in the context of different units of analysis and connect variations in EHR use to various barriers and facilitators. Findings from this study may help inform the design of the next generation of EHRs for the VA and other healthcare systems.

BACKGROUND AND SIGNIFICANCE
New technological developments, such as increasing electronic health record (EHR) use in the exam room, have introduced additional complexity into the traditional provider–patient relationship and encounter.1 2 In addition, some researchers have demonstrated that EHR use may alter the fundamental human reasoning and decision processes involved in healthcare.3 4 For example, a recent study illustrated many scenarios where clinicians’ cognitive models are not aligned with patients’ physical realities and the representation of those realities in the EHR.4 Understanding and addressing these types of unintended consequences that the EHR may have on the provider–patient relationship are essential if EHRs are to be used effectively. Effective implementation of EHRs has been shown to have positive effects on provider–patient interactions,5 6 as well as creating greater opportunities for patients to influence the behavior of their providers during their visit.7

Large integrated healthcare systems such as the US Department of Veterans Affairs (VA) and Kaiser Permanente have made large-scale efforts and investments to make computers and the EHR available in the exam room. The hope and expectation is that this technology can be integrated into clinical care and, once implemented, will be instrumental in improving therapeutic partnerships and the quality of care.8 However, the Institute of Medicine (IOM) chapter, ‘Preparing the workforce,’ suggests new or enhanced skills that will be required to achieve quality.9 These include skills in evidence-based practice, interdisciplinary teamwork, quality improvement, and informatics. In one way or another, the new skills outlined by the IOM depend on the use and mastery of information technology (IT). Providers must be able to effectively use informatics tools to communicate, manage knowledge, and support patient education and decision making. One tension inherent in the incorporation of these skills into clinical practice is provider concern that incorporating IT tools and EHR use into patient encounters may negatively affect their relationship with their patients.9 10 This concern may drive many of the variations in EHR use in the exam room. In addition, although numerous studies of EHR use have investigated data security, time efficiency, and information sharing among providers, variation in post-implementation EHR use and the effect of EHRs on clinical workflow have been slower to emerge. More research is needed to determine how to optimally integrate this technology into clinical workflows to better support clinical work.

The VA’s EHR, the Computerized Patient Record System (CPRS), is intended to support several functionalities, including the ability to view and update patient medical records, order prescription medications, laboratory tests and special procedures, and manage consultations.11 CPRS installation was mandated nationally in 1999, and virtually all clinicians in the VA now use CPRS across 1300 sites of care, including medical centers, outpatient clinics, and nursing homes.12 Yet, despite over a decade of use, problems with integration of CPRS into clinical workflow persist.13 14 For example, there is evidence that some clinicians circumvent the intended use of CPRS—for example, by using paper workarounds or refusing to use exam room computers at all.15 16 This circumvention may improve efficiency, but, in other cases, may lead to inaccuracies in the medical record.11 Other barriers to using computers in the exam room include typing ability, computer system speed, and usability issues.9 These barriers result in great variability in exam room computer use by physicians, although reasons for this variability are not fully known.17 Variations in computer use during patient encounters leads to questions about how best to integrate CPRS into clinical workflow. The primary goal of this study...
was to explore sources of variability in exam room EHR use in order to identify barriers to and facilitators of the integration of CPRS into routine ambulatory care workflow.

We frame our findings using different units of analysis for human–computer interaction. Assessment techniques often focus on a user interacting with a single computer interface. Frameworks such as cognitive engineering and distributed cognition expand the unit of analysis beyond the traditional computer system and user to include workflow and the organization at large. Three levels of analysis are applicable for EHR integration: computer interface, team coordination/workflow, and organizational (figure 1). The conceptual framework depicted in figure 1 was used in a study of barriers to and facilitators of effective use of computerized clinical reminders. We use this framework to organize our findings for variations in, barriers to, and facilitators of EHR use.

METHODS

We used a rapid ethnographic approach, with data-collection methods that included field observations, semistructured interviews, and opportunistic interviews. Primary care providers with various training backgrounds (eg, physicians, physician assistants, nurse practitioners) and levels of experience (eg, resident physicians, staff physicians) were invited to participate. Table 1 summarizes participants’ characteristics across each study site. Data-collection sites included three geographically distributed VA Medical Centers (VAMCs), which we refer to as ‘Southeast’, ‘Midwest’, and ‘Northeast’ VAMCs. We specifically chose these three sites because preliminary data indicated that EHR use varied widely across these medical centers, with low, medium, and high use of computers during patient encounters. Thus, the purposeful site selection of these three VAMCs was designed to capture maximum variation in computer use.

Ethnographic field observations

Ethnographic observations captured how providers employed the EHR in their ambulatory care patient encounters. These observations were made and recorded throughout the entire care process (before, during, and after the patient encounter). Data were collected by three research team members for each site. We used a structured observation form and opportunistically asked questions to clarify what we observed. Observations were recorded via handwritten notes on the observation form, capturing observable activities and verbal exchanges with patients and other staff (see online appendix 1 for the observation guide). The observation form included areas to identify participant and location, a rough sketch of the exam room, time, opportunistic interview probes, and observation content. Observers engaged in opportunistic interviews with the participants as time allowed. These opportunistic interviews allowed observers to follow-up on issues that arose during the observation, assess providers’ thought processes while using the EHR and/or related paper tools, and obtain providers’ feedback about their use of the EHR.

Semistructured interviews

Semistructured interviews were conducted to further understand differences in EHR usage among providers and facilities. The semistructured interview approach provided flexibility and gave participants an opportunity to identify and explain important information that might not have surfaced otherwise. At the same time, interview responses could be compared across interviews, since the same core questions had been asked of each participant. Barriers and facilitators were explored at the provider, clinic, and facility levels. The interviews were scheduled for 30 min, audio-recorded, and transcribed verbatim (see online appendix 2 for the interview guide).

Analysis

We used an inductive approach for our analysis and development of a code book as opposed to using predefined hypotheses to guide our analytic process. The entire analysis team (eight researchers) collectively reviewed complete datasets (observation notes and interview transcript) for three participants for emergent codes. During this initial team review, a code book was developed and refined (see online appendix 3 for the code book). The code book was used for the rest of the transcripts. Two independent reviewers coded segments of each provider’s set of ethnographic notes and interview transcripts using an Excel spreadsheet. Consensus reports were generated by comparing the Excel spreadsheets for each pair of reviewers. Discrepancies were discussed, with the goal of reaching consensus. The final consensus for each pair of reviewers was entered into NVivo. We used Excel during this initial coding phase because NVivo was not accessible to all members of our analysis team.

The next stage of analysis involved using NVivo to sort all of the data across participants and study sites by code. Team members received data sorted by code and independently

![Figure 1](https://example.com/figure1.png)

**Figure 1** Barriers to and facilitators of electronic health record (EHR) use according to three levels of analysis: EHR-interface, team coordination/workflow, and organizational. Human–computer interaction with the EHR expands beyond the computer interface level to include team coordination/workflow and larger organizational issues in a sociotechnical system.
Table 2 Variations in using the EHR with associated facilitators and barriers

<table>
<thead>
<tr>
<th>Patient care process</th>
<th>Sources of variation</th>
<th>Facilitators</th>
<th>Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing for patient encounter</td>
<td>Degree of trust in other providers (in terms of reviewing providers’ previous notes) Familiarity with patient/provider relationship (in terms of reviewing patient’s previous notes) Patient wait time (‘...if they’re a patient that has been waiting for awhile...I’ll just go and grab the patient and...start looking at the chart while they’re here.’)</td>
<td>Preparation: provider reviewing nurse’s note for patient before seeing patient</td>
<td>Workload: time to review EHR notes for new patients</td>
</tr>
<tr>
<td>Coordinating care (other data entry and maintenance tasks; eg, follow-up, care coordination)</td>
<td>Receiving phone calls for patient care Questions from other clinical staff Unexpected need to transcribe outside patient records into the EHR</td>
<td>Information transfer: coordinating with specialty clinics (follow-up); communicating with other providers through the EHR Managing workflow: provider can check whether patients have checked in for appointments (laboratory tests, clinic)</td>
<td>Communication between clinicians: using the EHR as a communication tool with other clinicians rather than face-to-face communication (countersignatures, computerized consults); care coordination Multitasking: accessing multiple patient records at the same time in the EHR; potential data entry errors Skills and training: lack of provider education; specific knowledge required for some EHR tasks</td>
</tr>
<tr>
<td>Face-to-face patient encounter</td>
<td>Patient behavior or mental state (eg, patient agitated, labile, patient distressed physically or emotionally) Discussing sensitive topics (impacts use of the EHR: provider doesn’t use the EHR with patient present) Answering unexpected patient inquiries during encounter</td>
<td>Provider–patient communication: Using the EHR as a communication and education tool between provider and patient; provider showing the patient data or test results on the screen Record completeness: using the EHR to confirm information from the patient (patient lost weight, understand history of a symptom, past physician visits) Efficiency and access: quick medication orders during patient visit</td>
<td>Ergonomics: physical layout causes extra glances back and forth between patient and computer</td>
</tr>
<tr>
<td>Documentation of patient encounter</td>
<td>New patients (may take longer to document) Patient acuity/complexity/simplicity (impacts timing of documentation) Walk-in patients (provider cannot finish note because she/he must wait for lab results, etc)</td>
<td>Customization: ability to customize EHR templates (eg, for documentation)</td>
<td>Documentation burden: time consuming to complete progress notes</td>
</tr>
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</table>

In some cases, the same item may be a facilitator and barrier. Under ‘Coordinating care’, for example, using the EHR as a communication tool among providers tended to be a facilitator for routine care activities (eg, receiving laboratory test results) and a barrier when face-to-face communication was needed for more complex care coordination or urgent issues (eg, patient needs specialty consultation immediately). EHR, electronic health record.

RESULTS
We found considerable variation in how the EHR was used before, during, and after patient encounters. Variation in EHR use centered on preparing for patient encounters (reviewing previous progress notes), documentation (completing new progress notes), impact on the patient encounter, and impact on clinician workflow as it related to coordination of care. The degree of preparation that providers performed in reviewing a patient’s previous progress notes before the visit was influenced by how familiar the provider was with the patient, the degree of trust in other providers who recently saw the patient, and how long the patient had been waiting since checking in. EHR use also varied during clinical workflow, including the patient encounter, and post-encounter documentation. These variations in the use of the EHR are inter-related with barriers and facilitators. Table 2 maps associated barriers to and facilitators of the sources of variation. For example, the barrier ‘documentation burden’ is exacerbated when a provider sees new patients (requiring longer initial documentation), walk-in patients, and patients with complex problems.

A complete list of barriers to and facilitators of EHR use revealed by our analysis is available (see online appendix 4).

DISCUSSION
We found several key sources of variation in exam room use of the EHR, as well as associated barriers and facilitators. The conceptual framework in figure 1 is used to organize our results into interface, workflow, and organizational level findings. The
majority of barriers and facilitators in our findings reside at the EHR-interface level. They include usability, data aggregation, signal to noise, multitasking, IT architecture, efficiency and access, record completion, error detection, and customization. Information transfer, communication between clinicians, and provider–patient communication were also related to the EHR-interface level along with team coordination and workflow. Ergonomics (including physical layout of the exam room and health IT), preparation, and workflow management related specifically to the team coordination and workflow unit of analysis (figure 1). Organizational level barriers and facilitators included workload, skills, and training. Organizational level policies that affected clinical documentation, as well as challenges in timing of documentation tasks and the interface design, made ‘documentation burden’ a barrier relevant to each unit of analysis in figure 1.

Although the VA has been a leader in the implementation and use of the EHR, important EHR capabilities have not achieved the impact they should because of multiple factors, including failure to apply key strategies and practices such as usability testing, redesigning work processes to optimally integrate clinical decision support into practice, and inconsistent and incomplete testing, redesigning work processes to optimally integrate clin-

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Data sharing statement

The data used in this study are from the United States Department of Veterans Affairs, which is not publicly available.

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Competing interests

None.

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REFERENCES


