Published in final edited form as:

J Patient Saf. 2011 December ; 7(4): 193–203. doi:10.1097/PTS.0b013e3182388cfa.

What stands in the way of technology-mediated patient safety improvements? A study of facilitators and barriers to physicians' use of electronic health records

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Abstract

Objectives—For electronic health records (EHR) systems to have a positive impact on patient safety, clinicians must be able to use these systems effectively after they are made available. This study's objective is to identify and describe facilitators and barriers to physicians' use of EHR systems.

Methods—Twenty research interviews were conducted with attending physicians who were using EHR at one of two Midwest community hospitals and/or at their respective outpatient clinics.

Results—Analyses yielded over 200 perceived facilitators and barriers, comprising 19 distinct categories. Categories of facilitators/barriers related to user attributes included learning, typing proficiency, understanding the EHR system, motivation/initiative, and strategies/workarounds. Categories related to system attributes were supporting hardware/software and system speed, functionality, and usability. Categories related to support from others were formal technical support, formal training, and informal support from colleagues. Categories of organizational facilitators/barriers were time allowance and inter-institutional integration. Categories of environmental facilitators/barriers were physical space, electricity, wireless connectivity, and the social environment.

Conclusion—Together, the broad set of discovered facilitators and barriers confirms and expands prior research on the facilitators and barriers to health information technology use. The depth of reported information on each facilitator and barrier made possible by qualitative interview methods contributes to the theoretical understanding of facilitators and barriers to EHR use. Equally as important, this study provides an information base from which relevant policy and design interventions can be launched in order to improve the use of EHR systems and, thus, patient safety.

INTRODUCTION

Electronic health records (EHR) systems are a prevailing intervention for improving quality and safety of care in the US[1–3] and abroad.[4] However, mixed evidence regarding the actual quality and safety benefits of EHR [5–10] supports the idea that it is not the mere

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presence of EHR that determines improvement, but rather how and to what extent clinicians use EHR systems post-adoption (i.e., once purchased and implemented).[11–13] When EHR systems are available, making safe and appropriate diagnostic and treatment decisions entails actually accessing information (e.g., problem lists, prior notes, test results) in the EHR rather than relying on memory or outdated handwritten notes. Information must not only be accessed, but also processed, which is facilitated by certain EHR use behaviors (e.g., putting information side by side, using sorting and graphing features, looking up additional reference information). To effectively, securely, and quickly communicate safety-relevant information to patients and fellow providers, clinicians must actually use built-in features. To take advantage of the improved legibility, completeness, direct transmission, and forcing functions afforded by an electronic system, providers must actually enter documentation and orders into the system and must do so in a clear and complete way. To intercept potential prescribing errors, physicians must appropriately respond to alerts issued by built-in decision support. In short, the safety benefits of EHR do not come through the mere presence of these systems but rather through their appropriate use. (Of course, there are other factors besides use that affect EHR's safety benefits, for example EHR design and implementation,[14, 15] the degree to which EHR supports cognition,[16–18] and the fit between the EHR and the clinical work system.[19, 20])

Several studies have identified facilitators and barriers to EHR adoption such as cost and difficulty procuring the system, physician resistance, and organizational characteristics (e.g., hospital size, ownership, and teaching status).[3, 21–25] However, those studies do not reveal what facilitates or impedes EHR use once EHR has been made available at a hospital or clinic. Given that limitation and the recent focus on “meaningful use” (rather than mere acquisition) of EHR,[26, 27] this study aimed to identify and describe the perceived facilitators of and barriers to physicians' EHR use.

Figure 1 depicts the conceptual framework for the study. It shows that the post-adoption stage is important in determining EHR outcomes such as patient safety.[28–30] Clinicians' post-adoption attitudes (i.e., acceptance/rejection) and behavior (i.e., use/non-use) are in part determined by facilitators and barriers, or factors that affect clinicians' ability to use the system in an meaningful way.[31, 32] Those facilitators and barriers are aspects of the work system [33, 34] such as user attributes, system attributes, support from others, organizational support, environmental factors, and control over behavior.[35] Although there are facilitators and barriers to adoption and achieving improved outcomes, this study focuses on post-adoption facilitators and barriers.

METHODS

Study design

Perceived facilitators and barriers were elicited using semi-structured qualitative research interviews called *belief elicitation* interviews.[36] An assumption of this method is that subjective beliefs, though they can be incongruent with reality, are important to assess because people's behavior is based on their beliefs or perceptions of reality.[37] A human factors engineer/psychologist trained in qualitative interviewing conducted all interviews. The study was approved by institutional review boards (IRBs) at the University of Wisconsin-Madison and at both research sites.

Sample and setting

Participants were attending physicians recruited from two 400+ bed Midwest US community hospitals. Twenty physicians participated, eleven from Hospital 1 and nine from Hospital 2. Respondents represented general medicine and a diversity of specialties and were practicing

an average of 15 years at the time of interviews. The same, top-ranked national vendor of inpatient hospital EHR provided system for both hospitals. Hospital 1 was using EHR for data retrieval only for three years at the time of the interviews (June–September 2007). Hospital 2 was using EHR with data retrieval and electronic documentation for nine months and computerized order entry for seven months at the time of the interviews (January–February 2009). (See Appendices for more information on hospitals, participants, and their EHR systems.)

Interview instrument

Interviews lasted one hour. Participants were asked the following questions intended to elicit perceived facilitators/barriers:

- “What factors or circumstances would enable you to use [EHR system]?”
- “What factors or circumstances would make it difficult or impossible for you to use [EHR system]?”
- “Are there any other issues that come to mind when you think about being able to or not being able to use [EHR system]?”

Question wording was based on wording specifically designed for psychological studies on facilitators and barriers to planned behavior.[38, 39] Scripted variations of these questions were asked if a participant had difficulty answering (e.g., “How would you fill in the blank: If not for ‘blank,’ I would not be able to use the technology like I want to”). Unscripted prompts were used to encourage further information and to keep responses focused on interview topics (e.g., “Anything else that helps you be able to use it?”). The interviewer provided encouragement, both non-verbal (e.g., a nod, taking notes) and spoken (usually, “Mm-hum” or “Okay”), following responses and was careful to not endorse responses in a biased way (e.g., favoring barriers over facilitators). Participants were also asked about the advantages and disadvantages of using EHR, social pressure to use EHR, and opinions about EHR implementation.[40]

Analysis

Transcribed interview passages were analyzed for references to facilitators and barriers, or factors, circumstances, or conditions enabling or prohibiting, respectively, intended EHR use. Identified facilitators and barriers were organized into six groups: four based on Mathieson et al[35]—“user attributes,” “system attributes,” “support from others,” and “general control-related”—and two additional groups needed to account for all the data—“organizational support” and “environmental factors” (see Figure 1). Analysis was guided by definitions of facilitators and barriers taken from social-cognitive theories of behavior. [41–44] QSR NVivo 8 (Cambridge, MA) software was used for storing and coding data.

RESULTS

Over 200 interview statements were coded as mentioning facilitators (127) or barriers (82) to the use of EHR and specific EHR functions (e.g., order entry, clinical documentation). On average, individual physicians reported about 10 facilitators/barriers ($M = 10.5$, $SD = 2.8$, range = 6 – 16), and were more likely to mention a facilitator than a barrier (average facilitator to barrier ratio = 2.1:1, range = 3:8 – 9:1).

Below, specific facilitators and barriers to EHR use are described, and illustrative passages (chosen based on clarity and representativeness) are presented in Tables 1 through 5.

User attributes

Six categories of facilitators/barriers were related to individual users, described below, ordered from most to least frequently mentioned (Table 1).

- **Learning.** Learning was often mentioned as a necessary and inevitable condition for efficient use of EHR. Physicians believed learning required time, repetition, and effort, and could not be avoided through design; instead, as one physician explained, one must adjust one's behavior over time to fit the design of the EHR (*"The machine has taught me to accept that"*). Physicians often spoke of learning through experience (*"I figured it out myself"*), for example, constructing a set of six clinical note templates that "evolved ... because that wasn't really part of the formal training."
- **Typing proficiency.** One physician identified fast typing as a facilitator; others perceived slow typing as a barrier and contrasted their difficulty acquiring *"keyboarding skills ... on the fly"* with the facility of younger colleagues. Faster typing permitted more substance in clinical notes.
- **Understanding the EHR system.** Lack of understanding of the system, e.g., how to navigate it, was attributed to unintuitive design. Conversely, a good mental model of the EHR's information structure facilitated use. Unfamiliarity with specific features, e.g., secure remote access, was a barrier to using EHR fully.
- **Motivation/initiative.** Some attributed use of EHR beyond their basic training to personal initiative (*"I put that on myself"*) and adventurousness, noting that personal initiative was important because initial training was insufficient, additional formal training required extra time, and the hospital did not promote certain types of use (e.g., electronic signatures).
- **Strategies/workarounds.** In addition to mastering built-in shortcuts, physicians reported developing routines (e.g., documenting the entire outpatient encounter in between patient visits vs. pre-typing notes during visit, finishing them later) that facilitated EHR use. Strategies sometimes involved working around standard protocol (e.g., entering a scheduled Saturday outpatient visit as a walk-in the day of the visit; entering freetext orders for nurses to put in using structured order entry interface) when physicians perceived the standard protocol to be problematic (e.g., caused awkward workflow, double entry, or time inefficiencies).
- **Other.** Remembering/forgetting the password, forgetting how to use EHR with the passage of time, and having unimpaired physical function were additional user-related facilitators/barriers mentioned.

System attributes

Four categories of facilitators/barriers were related to the EHR system and the software and hardware supporting it (Table 2).

- **Supporting hardware/software.** Almost every physician identified availability of computer stations and remote access software as facilitators of EHR use. Conversely, computers being busy (e.g., when *"you hit the rush hour"*), too few, or too slow were common perceived barriers. Remote access was sometimes hindered by lack of connectivity, not having the encryption card needed to log in, visiting patients in a place without Internet (e.g., nursing home), or needing Windows software.

- **Speed.** System slowness in some units, but not in others, was perceived as a barrier to use as was the slow, multiple-step log-in process. Log-in was complicated by the need to remember multiple passwords.
- **Functionality.** Physicians named multiple functionalities in the EHR system that facilitated its use, including order sets and pathways, customizable templates allowing information to be pulled from the EHR into clinical notes, an option to “copy and paste” (replicate) previous notes, keyboard shortcuts, and voice recognition-enabled documentation. One physician noted a functional barrier: only three patient profiles could be open concurrently.
- **Usability.** Half of those interviewed identified usability as a barrier whereas only three physicians, all at Hospital 1, described the system as easy to use, mainly because of the system's consistent format. Specifically mentioned were the system's lack of simplicity (the “broad, almost infinite way that you can do things ... makes it harder”), unintuitiveness, overly structured notes, fragmented information, and cumbersome outpatient scheduling feature.

Support from others

Three categories of facilitators/barriers were related to support received from others (Table 3).

- **Formal technical support.** Technical support facilitated use both in the initial days and weeks of EHR and afterwards. Support staff were generally perceived as knowledgeable and helpful, although some physicians noted that support staff were unavailable sometimes (off hours; holidays). Physicians were most appreciative of one-on-one, on-demand support during actual care scenarios.
- **Formal training.** Although initial formal training was depicted favorably by some, insufficient training was often identified as a barrier, either because there was not enough training or because classroom training was ill-suited to physicians' clinical needs and learning styles. Additionally, self-initiated continued training opportunities were perceived to improve one's use of EHR.
- **Informal support from colleagues.** In addition to formal support and training, many physicians said they were better able to use EHR from talking to and observing colleagues using EHR. Physicians borrowed tips and strategies from colleagues and also asked colleagues for specific help (e.g., troubleshooting; writing orders; discharging patients).

Comments about receiving support from others shared a theme: that physicians benefited most from support that was hands-on, in-person, and provided in practice rather than from formal classroom training. Similarly, some physicians preferred learning on one's own with an expert or colleague on hand to assist. Comments from a family physician at Hospital 2 illustrate this assisted-experiential-learning theme:

“Well, it, I think we need to see somebody who's using it. You know, using it live with a patient and walking through it and see how they do it. It would be great to have training staff there. You could even get more information or examples, but to sit in a separate room and to try to go through examples is good in the initial training, but I think once we've been on it, we need to see how people do it ... in real life. And that's why I think working with a doc who's good at it would be a good way to do it.”

Organizational support

Two categories of facilitators/barriers were related to organizational factors such as management and compensation (Table 4).

- **Time allowance.** Having extra time and a light patient load were perceived facilitators of use, whereas taking extra time to use EHR and not being compensated for taking a lighter load were perceived barriers. Physicians reported that they needed but did not always have time to use the system fully, to participate in further training, or to learn new features (“I don't have time to kind of be digging around and playing with things to figure that stuff out”).
- **Inter-institutional integration.** Physicians could not use patient data from EHRs to which they had no access, having to instead rely on printed documents. Physicians with care responsibilities across disparate health systems still needed separate log-ins for each system's EHR and commented that having a single, universal log-on would facilitate EHR use. At Hospital 2 inpatient and outpatient EHRs were integrated; at Hospital 1 physicians identified having to log in separately to inpatient and outpatient EHR systems as a barrier to “*seamless access*.”

Environmental factors

Four categories of facilitators/barriers were related to the physical or social work environment (Table 5).

- **Physical space.** Barriers included cluttered workspaces, insufficient space for a paper chart when using EHR, not enough private rooms for computer use, computer stations ill-suited to tall users, and physicians not being physically located at a computer station (e.g., when commuting).
- **Electricity.** Power outages, although very infrequent, did occur and were a barrier to EHR use.
- **Wireless connectivity.** A broadband connection and wireless connectivity facilitated use but these were not always available (e.g., at nursing home; in some outpatient clinics that a specialist might visit).
- **Social environment.** One physician described difficulty using EHR when a patient or family member could see others' private information on the screen. Another physician noted the need for privacy when using EHR but a lack of dedicated computer rooms. A third described discomfort typing and talking to the patient at the same time.

General control-related

Control-related facilitators/barriers were those that left physicians no other choice but to use (or not use) EHR in some way. By mandating the general use of EHR and removing alternative options (“*they don't keep paper backup copies*”), physicians' hospitals and clinics “facilitated” EHR use. In contrast, the unavailability of specific features (e.g., clinical notes and order entry at Hospital 1) was a barrier to using EHR for certain tasks.

DISCUSSION

The mere presence of EHR does not guarantee successful use of the system or of its specific functions.[11, 45–47] EHR use requires the presence of certain user and system attributes, support from others, and numerous organizational and environment facilitators. Additionally, difficulty using EHR and the non-use of specific functions result from the

presence of barriers. The present study identified and described 19 categories of facilitators and barriers based on the perceptions of attending physicians using EHR systems.

Other studies have formally identified similar facilitators and barriers to use of health information technology (IT). Linder et al's[48] survey of 225 primary care clinicians revealed barriers to EHR use during patient visits, including user attributes (typing speed), systems attributes (computer slowness; usability), organizational factors (falling behind schedule), and social factors (loss of eye contact; rudeness to patient). Saleem et al's[49] ethnographic study of 90 primary care clinicians using computerized clinical reminders at four Veterans Administration (VA) medical centers identified five barriers (provider coordination; not using system in patient's presence; workload and workarounds; system flexibility; usability and slowness) and four facilitators (number of reminders; computer workstation location; workflow integration; reporting/remediation of system problems). Patterson's outpatient VA studies also reported training, knowledge of the system, and computer availability as additional barriers to the use of computerized clinical reminders. [50, 51] Finally, several of the barriers identified here, such as usability problems and system slowness, appear in work that describes the unintended consequences of EHR.[52–58]

In general, the findings from this study accord with previous findings, despite the more specific definition of facilitators/barriers (centering on *ability*) used here. However, compared with observational studies, interviews with physicians uncovered more user-centered facilitators/barriers (learning; usability; training) and fewer externally observable ones (clinician-clinician or clinician-patient interaction; workflow). The exploratory and “naturalistic” rather than laboratory nature of the present study permitted the discovery of more facilitators and barriers than previously reported, spanning levels of analysis from “the larger organization down through ... the computer interface level.”[49]

Several study limitations must be noted. The study's small, non-random sample of only attending physicians limits the generalizability of the findings. The restricted sample may also have limited the breadth of facilitators and barriers that could be identified. Thus, it will be important to extend this study's methods to other organizations, professional groups besides physicians, and other technologies in order to broaden the knowledge base on facilitators and barriers to health IT use. The use of interviews permitted this study to capture perceptions, both a limitation and strength. Although perceptions are sometimes inaccurate interpretations of reality, they are key determinants of IT acceptance and use behavior and shed light on how individuals respond differently to the same IT.[59] Although user-reported barriers are subjective, they cannot be dismissed as simply complaints. Participants were able to clearly describe how barriers operationally affected EHR use, for example, how poor typing proficiency limited the volume and content of clinical documentation or how slow computers in patients' rooms rendered those computers nonfunctional, forcing physicians to document information outside the room and not in the presence of the patient. Nevertheless, the effects of reported perceptions on behavior and performance remain to be objectively assessed. Only a single method, interviews, was used. This limited the scope of data and precluded an analysis of the strength of reported facilitators and barriers. Future studies should simultaneously “bootstrap” multiple methods to permit triangulation.[51] Finally, this study focused on facilitators and barriers, but other factors surely influence EHR use, including additional barriers not identified here,[51] the perceived effect of EHR on performance,[18] social and personal normative influence,[60] and other cognitive and implementation factors.[13, 14, 20, 40, 61, 62]

CONCLUSION

In conclusion, this study identified and described facilitators and barriers to using EHR. Research interviews permitted both a good breadth of facilitators/barriers and often in-depth descriptions of each. Such level of detail both supports the theoretical understanding of each facilitator/barrier and helps inform design, policy, and organizational decision making. Indeed, by considering the factors identified in this study and accordingly designing the sociotechnical microsystem, it should be possible to improve the ability of clinicians to easily and effectively use EHR. That, in turn, will increase the probability of quality and safety improvements through EHR.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The author thanks study participants and Geoffrey Priest, Christine Baker, and Bradley Schmidt. Anonymous reviewers provided helpful feedback. This research was completed as part of a doctoral dissertation under the supervision of Ben-Tzion Karsh. RJH was supported by a pre-doctoral training grant from the National Institutes of Health (1 TL1 RR025013-01) and a post-doctoral training grant from the Agency for Healthcare Research and Quality (5 T32 HS000083-11).

SUPPORT: RJH was supported by a pre-doctoral training grant from the National Institutes of Health (1 TL1 RR025013-01) and a post-doctoral training grant from the Agency for Healthcare Research and Quality (5 T32 HS000083-11).

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Figure 1.

After an organization adopts electronic health records (EHR), clinicians accept or reject and use or do not use EHR and these post-adoption attitudes and behavior determine outcomes of interest such as quality of care, patient safety, and return on investment. Facilitators and barriers, among other causal factors, influence adoption, acceptance and use, and outcomes of interest.

Table 1

User attributes identified as facilitators and barriers to EHR use and example passages.

Facilitator/barrier	Example passages from interview
Learning over time	<ul style="list-style-type: none"> • “I’m learning things, as we go, I’m learning how to more efficiently use the system.” (Anesthesiologist, H1, on learning new features) • “...there are so many different ways of doing things that you have to figure out which way... works best for you. And we all do it differently, um, that I’ve, you know, it takes you awhile to find out which way is the right way for you, and what vitals, data, you know, do you like it in the graph form, do you like it in the table form, do you like it in a chart form, you know, which is the easiest way for you to process, and then customizing it.” (General medicine hospitalist, H2) • “Once you get used to the organization [of data], you can find things where they’re supposed to be.” (Family medicine physician, H1)
Typing proficiency	<ul style="list-style-type: none"> • “I’m not efficient enough as a typer [sic], uh, I talk much quicker than I can type.” (Family medicine physician, H1) • “... if you know keyboarding, which I’m a very fast typist, um, then you can have more substance into your notes. But if you don’t know keyboarding, you’re hunting and pecking. You’re not going to have a lot of content in your note, because it takes you too long.” (General medicine hospitalist, H2)
Understanding of EHR system	<ul style="list-style-type: none"> • “...presuming you know where to find the data, you can find the data.” (General medicine hospitalist, H2) • (Interviewer: “And so anything else that you’re able to think of, any issues that come to mind of being able to use, uh, the system?”) “No, I think probably just my level of understanding the system and lack of understanding of, you know, some of the basic computer principles.” (Family medicine physician, H2) • “...for like, uh, checking on particular lab trends, you know, I don’t know quite how to use the graphing function over time.” (Rheumatologist, H1)
Motivation and personal initiative to explore and learn EHR system	<ul style="list-style-type: none"> • “I just went on there and started doing it. #laughter# That’s how I do everything” (Psychiatrist, H1, on learning to use EHR on her own) • “I worked hard, I haven’t dictated ... I started decreasing dictation as a method of documentation” (Family medicine physician, H2, on taking initiative to type clinical notes) • “...it doesn’t bother me a bit to learn a new way to do things.” (Family medicine physician, H2)
User-developed strategies and workarounds	<ul style="list-style-type: none"> • “We find ... little shortcuts here and there all the time” (Family medicine physician, H1) • “I’m typing in an order to the nurse, and I’ll say, you know, I’ll just write it out freehand, change the diet to this, you know, change the IV to that, and then basically, I’m using the electronic tool to do what I used to do in the paper world, which is write down exactly what I want, send it to somebody else and let them figure out how to make it happen, because I am not going to spend that 20 minutes figuring out something that takes five seconds. That’s a workaround.” (Family medicine physician, H2) • “I came up with a new flow about a month ago, so that I wasn’t sitting there doing all this documentation in front of the patient ... between every single patient, I go into my office and document while they’re, you know, checking in the next one. And I think it’s better patient, better flow for the patients, more running around for me” (Ophthalmologist, H2)
Other	<ul style="list-style-type: none"> • “If I can’t remember my password, I can’t use the system.” #laughs# (Obstetrician, H1) • “It’s just the fact that I’m using it somewhat sporadically ... So the intermittent, or sporadic use and the sporadic use of different aspects of the inpatient software, you know what I mean, where I might have used it really well at one point, but I’ve kind of forgotten exactly how best to use it. And I go back to using it in a clunkier way, because I understand how to use it that way. I’d forgotten some of the tips I learned.” (Family and sports medicine physician, H2) • “I have two hands, all my fingers function, and my eyes work. If I didn’t have that, it would be a problem. I’ve wondered many times, so what happens when you have someone who has visual impairment or has, is handicapped and, you know, they might be able to talk and dictate fine, but they can’t manipulate a computer, for some reason.” (Family medicine physician, H2)

H1 = Hospital 1, H2 = Hospital 2, EHR = Electronic health records

Table 2

System attributes identified as facilitators and barriers to EHR use and example passages.

Facilitator/barrier	Example passages from interview
Supporting hardware and software	<ul style="list-style-type: none"> “One of the biggest facilitation [is] the remote access, um, because as much as you like to do things real-time, the world doesn't let you do everything real-time because of competing goals and needs and such. So the ability to access it from home, access it from the hospital, use downtime more efficiently, um, whereas before, if you, you had downtime at a time where your, the charts were, you know, 10 miles away, you weren't going to be able to do anything.” (Family medicine physician, H2) “At the hospital, there are computers everywhere, so access is, is very easy. And so I think access to the, to a computer was an important part of what made it easier. There are, um, a number of them scattered through the central nursing station. There is a computer on wheels in every room, used more often by the nursing staff for bedside, but I would log on to that occasionally.” (General medicine hospitalist, H2)
Speed	<ul style="list-style-type: none"> “I don't have trouble finding a computer. I have to find a computer that has the speed to run the program, because definitely the ones in the hallways are a hell of a lot slower. I wonder if anybody uses those.... And some of the ones in the patient's room are very slow. I would like to be able to just pop in the computer, right at the patient's bedside, I mean, write the note right there, but those are just way too slow.” (General medicine hospitalist, H2) “...once you're in there it's fast, uh, if you have a good line. So rarely freezes up.” (Obstetrician, H2, on system speed via remote access) “...you need to put in username, password, and, I mean, but you have to boot it up #laughs# you know, we don't have our system necessarily up and running the whole time, so you have to sit down, turn it on, log in. So, there's a slight delay.” (Anesthesiologist, H1)
Functionality	<ul style="list-style-type: none"> “...there's obviously things like order sets and pathways which are, which really facilitate your use. Um, if they didn't have those, it would be a problem ... Um, obviously the templates are very handy.” (General medicine hospitalist, H2) “Ann Jones is admitted to the hospital with pneumonia. Well, I can take her note from yesterday, I can copy it, put it in as today's note, and everything automatically refreshes. And so that way, I can use that and just edit what I need to, depending on what the plan of the day is.” (General medicine hospitalist, H2)
Usability	<ul style="list-style-type: none"> “I just wish it were a much more user friendly ... they would say, well, there's multiple ways to do your progress note, for example.... I think most docs don't really want multiple ways to do the same thing. I think what we want is the most efficient way to do one thing, and so I wish they'd of said, here's the way you're gonna do your notes.” (General medicine hospitalist, H2) “...it's not an intuitive system ... if you haven't been instructed in how to use it, it's, uh, almost impossible to sit down and, looking at icons, navigate through to get to the information that you need” (Anesthesiologist, H1) “Uh, sometimes the way the information's formatted ... We're still kind of used to flipping through a [paper] chart, and then being able to pick up by Gestalt what's important. Now, this is a little different, getting used to it ... Well, you just get one screen at a time, and then you have to click, while the chart you could flip through quickly.” (Rheumatologist, H1) “But the programs are very straightforward. They know that docs don't know what they're doing with computers, so they make it easy for us.” (Psychiatrist, H1)

H1 = Hospital 1, H2 = Hospital 2, EHR = Electronic health records

Table 3

Identified facilitators and barriers related to support from others and example passages.

Facilitator/barrier	Example passages from interviews
Formal technical support	<p>During implementation:</p> <ul style="list-style-type: none"> “Well, having extra staff available, this past week, to help us ease the transition, was very useful. When I had an issue, I paged this individual, they came and they, we got through it. So it was very helpful ... I'm learning things, as we go, I'm learning how to more efficiently use the system, only because I'm getting someone who's knowledgeable sitting by my side, and helping through things. And these were things that weren't even taught to us in the [training] session, but they're turning out to be fairly useful.” (Anesthesiologist, H1, on order entry implementation) “And what was really terrific was ... we had one-on-one, pretty much, in the clinic, when we were, when we had the go live. And, um, that's where I think I really learned what it was that I needed to do, because there was somebody there, and when something didn't work, they were making calls, while I continued to see the patient. Um, so I think they made it as painless as possible.” (Ophthalmologist, H2, on outpatient EHR implementation) “And not always were there adequate people after hours, or down in the ER ... who were available in that initial couple weeks.” (Family and sports medicine physician, H2) <p>Post-implementation:</p> <ul style="list-style-type: none"> “...having individuals that we can readily access, to answer our questions when we're having trouble questions, is very helpful. If there was no support, it would be a very real challenge, I mean, it would just not work without any knowledgeable people to help you through it.” (Anesthesiologist, H1) “I remember one [support] person in particular ... she actually took a very pragmatic approach, which was basically like, well, here's this whole workbook of stuff you're supposed to get through, but let me just show you the most salient features, and you can do the rest of the stuff on your own. And I truly appreciated that, given that I don't have a lot of time in my day for huge, multi-hour training sessions. Um, uh, having a more pragmatic approach, and then having her available later, so I could call her, or e-mail her, and say, what was that again, how do I do that? Uh, or she would come up, and she would say, okay, well, let me come up and I'll just show you, I'll walk you through it. Um, that was actually great.” (Psychiatrist, H1)
Formal training	<ul style="list-style-type: none"> “The training was, you know, part of the problem is I learn really quickly, and the training was fast, but, you know, you forget it the next day. And I always do computers, I mean, I learn by trial and error anyway, so....” (Orthopedist, H1) “Um, the problem is, is that, at least initially, you were in a, um, practice environment and you weren't in the real deal.” (General medicine hospitalist, H2) “I think the people [who did the training] were very knowledgeable, what they didn't know, they found out for us.” (Ophthalmologist, H2) “...I would say continuing education opportunities and knowledge of the system is obviously very helpful.” (General medicine hospitalist, H2)
Informal support from colleagues	<ul style="list-style-type: none"> “...obviously, we had training to use the system, and I think that was important. Probably more important have been colleagues sharing tips and kind of best practice or best use. Those are the most useful things for me ... for example, um, I struggled initially over the first couple months to make my notes useful and in a reasonable format in the inpatient setting ... I was talking with one of the hospitalists that I work with, and just was saying, gee, I can't get the format the way I'd like. He said, oh, one of my colleagues is really great on computers. She formatted a, a great note. Do you want to see it? And I said, yes. And then, um, I said, oh, my gosh, that's so much more useful than what I would have, um, compiled on my own.” (Family and sports medicine physician, H2) “When you didn't know how to find some information, um, you could walk over to a unit clerk or ask somebody else, and I will bet you that almost every day, if not every day, every other day, um, a doc will be talking to another doc or a doc to a nurse or a nurse to a doc, how do I do this, um, how do I order this, how do I see this, how do I get to this piece of information, you know, we sort of teach each other because, because we weren't taught any other way.” (Family medicine physician, H1) (Interviewer: If you have trouble, is there somebody you can go to for help?) “I usually talk to my office manager, who's not part of the IT team, but he's relatively IT savvy. But if I had to call somebody within the IT team, that gets a little more complicated.” (Rheumatologist, H1) “...the people that use it in the hospital everyday, are more than willing to help, so they know that I'm only there sporadically” (Ophthalmologist, H2)

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Table 4

Identified facilitators and barriers related to organizational support and example passages.

Facilitator/barrier	Example passages from interview
Time allowance	<ul style="list-style-type: none"> “I’m probably the only one that’s fully using the system without dictation at this point, and the only reason I can do that is ‘cause I have a light schedule.” (Cardiologist, H1) “...we don’t always have sufficient time to take care of, to do our job, and yet log into the computer and fill out the order sheets.” (Anesthesiologist, H1) “...it’s just all this, what seems to be additional work, um, just takes a lot of time. And ... I know there’s no increased compensation for us for taking the time [to do what appears to be “ (Family medicine physician, H1) “I think the major, uh, issue is time for training.” (Family and sports medicine physician, H2)
Inter-institutional integration	<ul style="list-style-type: none"> “...what happens when I get somebody from another system that’s using [same EHR brand], I won’t be able to look at them on the computer. What usually comes in, they come up with printed notes from [same EHR brand] from that other system...” (Rheumatologist, H1) “right now we’re having three different [EHRs]...” (Obstetrician, H1, referring to having to access separately outpatient, inpatient, and university EHRs)

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Table 5

Identified facilitators and barriers related to the physical and social work environment and example passages.

Facilitator/barrier	Example passages from interview
Physical space	<ul style="list-style-type: none"> “...for sure you need organized workspace ... some of our workstations there are so damn cluttered now, because we’ve plopped technology on the old [workspace] ... in this workstation, there was literally nowhere #chuckles# where you could even set down something, because there were so many wires and everything piled ... and it’s like holy cow, I got to dig to find the keyboard.” (Family medicine physician, H2) “Right now, we’re in a transition phase where a majority of our medical record is still in the [paper] chart. The chart has to be set down someplace and written in, right? Which means that I have to find a horizontal surface upon which I can set the chart in proximity to a computer where I can also look up the labs or whatever else I’m looking for, right? Um, there is one incompletely inadequate space where I work to do that, and usually there’s already four people sitting there. Um, the work, those [computers on wheels] can’t be used for that because there’s no place to put the chart ... normally I have to shoo about eight, you know, eight people out of the way and say, I need to be in this space right now.” (Obstetrician, H1, referring to needing space for paper chart when using EHR) “I’m fairly tall, they’ve put some [computers on wheels] on some floors in a place that I have a difficult time standing and trying to use, because they’re way too low and they’re not adjustable.” (Family medicine physician, H2) “I could be driving to the office in my car and because I have a cell phone people have a way to get a hold of me and ask me do I want to change this or create this order, and I’m not at a computer terminal, nor will I be for an hour...” (Family medicine physician, H2, on not putting in orders directly in the system)
Electricity	<ul style="list-style-type: none"> “When the power goes out, you’re pretty much sunk. Fortunately, that’s only happened, um, oh, I’d say a total of two and a half hours over the last three years we’ve been up on it, at, in an outpatient world. Inpatient, um, honestly, I don’t think I’ve ever seen them where they haven’t had power, but they have a back-up generator, too, so it’s, you know that’s helpful.” (Family medicine physician, H1) “...if you have a power failure, which isn’t common but has happened to us. We’ve, you know, been in the middle of taking care of patients, they were doing construction, they cut into a power line, boom, no power in the whole clinic. Suddenly, uh, we’re back to #laughs# writing things on, you know, on pieces of paper, and you can literally access none of the information. So when you don’t have a paper backup, you’re screwed if you don’t, you know, if the technology is not available to you.” (Family medicine physician, H2)
Wireless connectivity	<ul style="list-style-type: none"> “...all I need is a broadband line, that would be one facilitator, I’m thinking...” (Obstetrician, H1) “...the biggest things are, is that, you know, in the operating room there is a wireless network, you know, set up with routers spread throughout the operating rooms. You can actually walk around the operating room with ... tablet computers up there. Um, and, so you don’t have to be locked into one spot in the operating room, the ability to access [EHR] is anywhere in the operating room and recovery room theater.” (Anesthesiologist, H1) “...there are some technical barriers. Um, we don’t have ... widespread wireless available [in outpatient clinics across the state].” (Cardiologist, H1)
Social environment	<ul style="list-style-type: none"> “I worry about using computers around the patients sometime. Because when you pop into your patient’s list, the family is hovering around the computer, then they can see other people’s name and that would be, I mean, it’s a HIPAA violation, so you’re real reluctant to use it. And more when you use it, you got to kind of pull it away where only you can see it kind of a thing. And I’ve been on computers where I’m talking to a doctor, looking at data in the computer, and somebody, you know, a patient family member or something walks up. And they just stand there, and I’m trying to push them away or shoo them away, because I need the data out of the computer while I’m talking to the consultant, and they’re not getting it. #laughter#” (General medicine hospitalist, H2)

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