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PHYSICIANS' BELIEFS ABOUT USING EMR AND CPOE: IN PURSUIT OF A CONTEXTUALIZED UNDERSTANDING OF HEALTH IT USE BEHAVIOR

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Abstract

Purpose—To identify and describe physicians' beliefs about use of electronic medical records (EMR) and computerized provider order entry (CPOE) for inpatient and outpatient care, to build an understanding of what factors shape information technology (IT) use behavior in the unique context of health care delivery.

Methods—Semi-structured qualitative research interviews were carried out, following the beliefs elicitation approach. Twenty physicians from two large Midwest US hospitals participated. Physicians were asked questions to elicit beliefs and experiences pertaining to their use of EMR and CPOE. Questions were based on a broad set of behavior-shaping beliefs and the methods commonly used to elicit those beliefs.

Results—Qualitative analysis revealed numerous themes related to the perceived emotional and instrumental outcomes of EMR and CPOE use; perceived external and personal normative pressure to use those systems; perceived volitional control over use behavior; perceived facilitators and barriers to system use; and perceptions about the systems and how they were implemented. EMR and CPOE were commonly believed to both improve and worsen the ease and quality of personal performance, productivity and efficiency, and patient outcomes. Physicians felt encouraged by employers and others to use the systems but also had personal role-related and moral concerns about doing so. Perceived facilitators and barriers were numerous and had their sources in all aspects of the work system.

Conclusion—Given the breadth and detail of elicited beliefs, numerous design and policy implications can be identified. Additionally, the findings are a first step toward developing a theory of health IT acceptance and use contextualized to the unique setting of health care.

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Keywords

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1. Introduction

The promise of health information technology (IT) improving health care outcomes [1] can only be realized when health IT is accepted and used effectively by clinicians [2]. Yet, numerous studies show that even the most well-meaning, safety-oriented clinicians do not use available IT [3-5], override or work around it [6-8], or use only some of the available features [9,10]. Of present interest, electronic medical records (EMR) and computerized provider order entry (CPOE) are two promising health ITs whose success has been stalled in part by problems of acceptance, underuse, and use deviating from what is expected by the organization [11-14].*

Because of the importance of understanding clinicians' acceptance and use of EMR and CPOE and the shortage of such individual-level research [3,10,15], this study sought to identify and describe the beliefs that might shape physicians' acceptance and use of EMR and CPOE for inpatient and outpatient care.

1.1. A study of physicians' beliefs about using EMR and CPOE

Decisions to accept and use health IT are neither random nor irrational. Instead, they result from tractable motivational and decision-making processes [2] and individuals' beliefs and experiences serve as input into those processes [16,17]. In this study, interviews were used to elicit various acceptance- and behavior-shaping experiences and beliefs that physicians had about using EMR and CPOE. The *a priori* beliefs categories of interest and the questions used to elicit beliefs were based on the social-cognitive Theory of Planned Behavior (TPB) [18, 19] and various expansions thereof [20,21] (see Table I).

Some health IT researchers have advised the use of *beliefs elicitation* methods [22,23] with categories and definitions similar to those in Table I [24,25] and there has been one such study, although the elicited beliefs were not reported [25]. Therefore, this paper is the first to describe in detail results from a beliefs elicitation study of health IT, focusing on physicians' use of EMR and CPOE for inpatient and outpatient care. A key goal of this study was to capture context-specific beliefs, or beliefs that reflect the unique aspects of IT use in health care—e.g., the particular technologies, the clinician users, the role of the patient, the collaborative and distributed process of care delivery—that distinguish it from instances of IT use in other industries [24,26-28].

2. Methods

Beliefs about EMR and CPOE use were elicited using qualitative research interviews. The beliefs asked about were ones posited in the original TPB and recent extensions (Table I).

*Other reasons for EMR and CPOE "failure" include (1) the design of "buggy" software as well as software that facilitates errors in clinical performance (e.g., due to inadequate feedback or inadequate separation between two options that can be clicked); and (2) improper implementation of such systems (e.g., too fast or with inadequate training). Software design and implementation problems can also influence physicians' acceptance and use of IT.

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2.1. Participants and the EMR and CPOE systems

This study was conducted with attending physicians who had inpatient responsibilities at one of two large (400+ beds), urban, tertiary care community hospitals in the Midwest. Twenty attending physicians participated, eleven from Hospital 1 and nine from Hospital 2 (see Table II).

Both hospitals had a functional EMR system in place at the time of the interview. Both hospitals were using the same brand of EMR but were at different points of the timeline for implementing EMR components. Hospital 1 had an EMR that had data retrieval but not data entry functionality. At the time of the interviews, they had this system for about three years and were just beginning to implement CPOE. Two participants from Hospital 1 worked in the first hospital unit to implement an order entry module; those participants provided data on the first few weeks of using CPOE. Hospital 2 had both data retrieval and data entry (documentation and CPOE) capability. The data repository and documentation portions of the EMR were in place at Hospital 2 for about 9 months and order entry for about 7 months. Ten of the 20 participants also provided data on their use of outpatient EMR and CPOE at their primary care clinic.

The same national vendor provided commercial EMR and CPOE systems to both hospitals and to both outpatient clinics. As such, clinicians often referred to EMR and CPOE by one name and treated order entry as an extended functionality of EMR. Treating order entry or CPOE as one part of an advanced EMR system is not uncommon in the literature [29,30] and participants were not discouraged from talking about “the system” as a whole. At the same time, participants were strongly encouraged to report any beliefs pertaining to CPOE and other specific functional components (e.g., discharge notes), which they did. Sometimes, when it was not clear to which system participants were referring, the interviewer asked for clarification. In reporting the results, “EMR and CPOE” refers to the EMR and all its capabilities, including computerized order entry, and function-specific beliefs are identified as such.

2.2. Procedure

A purposive (non-random/non-probability) convenience sampling strategy [31] was used to recruit physicians from the two hospitals. The study author, a human factors researcher trained in qualitative interviewing, conducted each 60-minute interview. Every participant consented to the interview and to being audiorecorded. The study was approved by IRBs at the University of Wisconsin-Madison and at both study hospitals.

The semi-structured interview instrument was developed specifically for this study based on several available guidelines for beliefs elicitation interviews [32,33] and pilot testing. Table I contains a list of key scripted questions. Additionally, the interviewer asked follow-up questions to probe deeper or to obtain clarification and examples.

2.3. Analysis

Transcribed interviews were subjected to a coding process, wherein themes were identified, and passages from the interview were attached to corresponding thematic codes. This process is alternatively called *descriptive coding* [34] or *open coding* [35]. Codes were hierarchically arranged, such that a broader theme might contain subthemes, those subthemes might contain subthemes, and so on. The software package QSR NVivo 8 (Cambridge, MA) was used to create, update, and manage thematic codes.

Only a single researcher analyzed the data, rather than having multiple researchers conduct independent analyses. Some researchers discourage using the multiple-analyst approach as a “validity test” on the basis that differences in coding are inevitable and do not necessarily result

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from invalidity [36]. This study used alternative means to ensure and assess validity [37-39], including (a) using well-established, theory-based definitions and analytic criteria to classify and interpret raw data (e.g., to identify utterances that described an "instrumental outcome" or to determine what constituted a "belief"); (b) critically examining and re-examining analytic decisions, making changes when subsequent data challenged past coding decisions; (c) requesting non-participant clinician contacts at the study hospitals to review the analyses for invalidity; and (d) making original data and coding decisions available upon request to external auditors who can review whether the analysis abides by the underlying theory.

3. Results

Themes, or commonly mentioned "modal beliefs" [22], that emerged within each category of beliefs are presented below.

3.1. Behavioral beliefs: Performance outcomes

Physicians believed that in many ways EMR and CPOE use improved the ease of personal performance. One perceived improvement was that physicians could now access medical records remotely, from home, from their clinic office, or from anywhere in the hospital, without needing to search for the paper chart. Immediate access to information such as laboratory results was perceived to speed up work; as one physician put it, "I can very quickly get the nuggets of information that I need, versus … looking around and asking the personnel on the floor, 'Where is the old chart?' 'Oh, it's on microfilm.'" Information was also perceived be more easily accessed or found in part due to collating and sorting functions in the software. Physicians believed that much information was available in one place, some of which was previously unavailable in paper charts, and could be accessed all at once, particularly by using the synopsis feature of the software. Retrieved information was also perceived to be legible and therefore easily understood: "There were many physicians whose notes I couldn't read or couldn't figure out most of what they said before … I can read them all now."

Aside from making personal performance easier, physicians perceived EMR and CPOE to improve the quality of performance. In particular, they described more accurate and timelier awareness of patient status, trends, and other information, with many physicians appreciating that chest X-rays, CT scans, and other results were available in real time. Importantly, having information was thought to improve clinical decision making: "the amount of information that will be missing from my knowledge base, as I'm making … decisions about my patients, is small." Some perceived that communication with colleagues and nurses was improved, both in general through better documentation, and through formal features such as secure EMR-based messages. Some physicians felt that CPOE improved the ordering process. Said one physician, "if you go to the EMR and you order it, you see exactly what it is that you ordered, so I think the potential for improved order accuracy." Another physician explained that having CPOE order sets reduced reliance on memory and improved accurate ordering. Physicians using data entry/CPOE also felt that colleagues' performance improved, primarily due to more legible notes and orders.

Yet, many perceived that EMR and CPOE worsened performance and made performance more difficult and more complex. Information such as colleagues' notes, medications on the discharge list, and data from other hospitals, was described as difficult to access or find ("I'm a savvy user and even I find it cumbersome to get the information"). Some old records, notes, and test results, were simply not in the system. Additional demands and extra steps were perceived to increase physicians' burden. In particular, physicians said that CPOE required numerous clicks and screens to navigate. Selecting from options rather than directly writing out the desired order, as in the past, was seen as problematic: "when you pop in potassium, for example, I mean, they give you a whole glossary of different types of potassiums that you just

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… don't need." CPOE alerts (e.g., allergy warnings) required further clicking and were perceived as blocks in performance, as were other new requirements such as someone needing to order a consult in the system before a physician could provide care. Perceived performance decrements stemmed from reduced ability to stay aware and informed, because information was sometimes missing (e.g., no problem list; missing radiological information; not being able to tell at discharge what medications were added or removed during hospitalization); clinical notes in EMR were described as less personal, less informative, and less complete than were notes in the past; and some believed that EMR made it more difficult to tell trends or take in the gestalt. Another perceived source of performance decrement was the reduced ability to see physician colleagues' thought process. Several spoke of this as a problem of "garbage in, garbage out," for instance, "the note is only as good as the content in the note. And there's some people who put enough into the note so that I could follow their train of thought, and some do not" and "it's very hard to tell what the physician was thinking now with the way most physicians document."

3.2. Behavioral beliefs: Productivity and efficiency outcomes

Some physicians believed that EMR and CPOE improved productivity over the previous paper-based system, stating reasons such as "it probably increases productivity, since I physically don't have to move that much around" and because "the actual sifting through data part of it is a lot better and is a lot faster." Others believed that EMR and CPOE only initially reduced productivity, although several outpatient clinicians noted that even four years into EMR and CPOE, they were compensating for decreased productivity by working longer hours. A large number of comments about using EMR and CPOE pertained to the effect on time-efficiency. 70% believed that EMR and CPOE saved time or sped up the care process, especially when retrieving information. However, almost every physician could also provide examples of perceived inefficiencies and time loss created by EMR and CPOE use, either by causing delays (e.g., when logging on or waiting for someone to enter data) or by slowing down the process. A common example of the latter was the perceived slowness of computerized documentation and ordering processes as a result of having to use the keyboard and mouse, especially when ordering medications. Said one physician, "It's, you know, ten boxes to click instead of a quick, written-out thing [medication order] that would take, literally, three to five seconds. Now it's, you know, it might take me minutes…"

3.3. Behavioral beliefs: Patient outcomes

Physicians believed that patients were benefiting from EMR and CPOE in several ways. Quality of care was thought to increase with EMR and CPOE use by allowing physicians to access more up-to-date information more quickly, by providing reminders (e.g., "I have to attend to the fact that, you know, they're overdue for a colonoscopy"), by speeding up the delivery of care (e.g., "if a test gets done earlier in the day"), and by reducing the number of duplicate procedures that might have previously been ordered because of the difficulty of knowing which procedures had already been done (e.g., "It saves them from any unnecessary X-rays"). Reduction in duplicate tests was also believed to save patients money. Further, faster ordering and order processing was seen as a way to save patients' time and reduce their length of stay and, presumably, associated costs. Numerous patient safety benefits were believed to arise from EMR and CPOE use. For example, a physician said, "there are just so many checks now to make sure that things are done safely." Mentioned checks included mandatory medication reconciliation, easier checking of medication history by pharmacists, and automatic checks for patient allergies and drug-drug interactions. Further, safety was thought to have improved due to improved data entry, in particular, orders that physicians described as clearer, more legible, and no longer abbreviated. Some physicians thought that patients were better informed as a result of EMR, for example because physicians could provide timely information

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through secure communication channels or because patients could go home with discharge reports printed from the EMR.

There were perceived EMR and CPOE use-related costs to patient outcomes as well. Of all participants, 40% (and 78% in Hospital 2) believed that EMR and CPOE use threatened patient safety due to, for example, physician over-reliance on potentially erroneous information, nurses focusing more on complying with EMR use protocol than on independently reviewing order accuracy, orders in the system not being seen or neglected, and physicians speeding through the system or ignoring CPOE alerts because they were used to false alarms. Quality of care outcomes perceived to be jeopardized by EMR and CPOE use. Mentioned reasons included perceived delays and poorer care resulting from nurses who were less familiar with EMR and CPOE not acting on orders; longer outpatient wait times as physicians spent more time on electronic documentation, and more time spent with the EMR than with the patient. Sometimes lab results arrived late in the system, even after the patient was discharged, and this was seen as harming care. Further harm was perceived because errors in the system were sometimes propagated when physicians copied and pasted blocks of information, rather than creating information from scratch.

3.4. Behavioral beliefs: Financial, organizational, and other outcomes

Physicians believed that some cost savings resulted from eliminating dictation and paper and improved billing efficiency for billing departments and for individual physicians. However, physicians also believed that EMR and CPOE use caused an inefficient use of resources. In particular, physicians believed strongly that it was or soon would be a waste of human resources to have physicians enter data: “from a pure business standpoint, it makes very little sense, you know, to have a highly paid … stressed out physician, who may or may not be a good typist, or, um, may or may not be a computer whiz, trying to do the data entry.” Other commonly mentioned undesired outcomes were the perceived intrusion of work on home life made possible by remote access and the perceived inability of EMR and CPOE to accommodate the complexity and variety of clinical needs. As two examples, some specialty-specific tools were described as lacking (e.g., for drawing retinal images of ophthalmology patients) and template-based data entry was perceived to not allow physicians to tell a rich, patient-specific story in their notes.

3.5. Behavioral beliefs: Affective outcomes

In general, responses pertained to instrumental, not affective, outcomes. This was expected, because the standard behavioral belief questions used in the interviews were not tailored to eliciting affective beliefs; such questions favor elicitation of instrumental over affective beliefs [23]. Nevertheless, some affective reactions were described. Consistent with prior CPOE studies [11], most (91%) were negative reactions such as frustration, irritation, and resentment (e.g., “I'm highly resentful of the fact that somebody's using me as a very overqualified typist”).

3.6. External normative beliefs

Several entities internal and external to participants' hospitals or outpatient clinics were perceived to approve or encourage physicians' EMR and CPOE use. By far the most often mentioned internal entity was the hospital administration; the outpatient clinic administration was also often mentioned. Said one physician of the hospital's encouragement of EMR and CPOE use, “that's part of their message, that this is kind of the way medicine is going, and we need to do this.” Inpatients and outpatients were also perceived to encourage system use, although 40% of physicians believed that inpatients were unaware of the system. External entities believed to approve or encourage use included political entities, particularly the government (note that Hospital 2 interviews took place in January-February 2009, during the Obama administration's push for health IT); professional organizations (e.g., American

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Association of Orthopaedic Surgeons, American College of Physicians); payers; and national advocacy organizations (e.g., Leapfrog Group) and regulatory agencies (e.g., Joint Commission).

Entities discouraging EMR and CPOE use were seldom mentioned; the only commonly mentioned entity was “fellow users.” Indeed, when asked about entities that disapproved or discouraged their EMR and CPOE use, over a third of physicians answered that there were none.

3.7. Personal normative beliefs

Participants identified themselves as professionals and physicians and sometimes mentioned that it was not characteristic of someone in their role to do data entry work. Other self-identifying beliefs were on a personal level (e.g., “I'm a typist,” “I'm a savvy user,” “I like computers”). Moral normative beliefs related to EMR and CPOE use were most commonly those related to the confidentiality, privacy, and security of patient records. One physician explained, “my reservations and concerns about it are mainly about, um, the ability to safeguard the information in a way that, uh, doesn't, um, expose people to possible adverse consequences as a fact … as a fact that their records are now more easily accessible by more people.” Some physicians liked that access rights were restricted to those who had care responsibilities but wanted to maintain exclusive rights to reorder medications or access raw data, rather than sharing those rights with office staff and patients. Finally, although some perceived that using EMR and CPOE was a moral obligation (e.g., “[there are now] moral obligations on physicians to embrace the record to improve patient safety”), others had no moral normative beliefs or believed that EMR and CPOE were morally neutral (e.g., “There's nothing in my Bible that, that discourages … the use of EMRs”).

3.8. Control beliefs: Controllability

For the most part, physicians believed that using EMR and CPOE was not under volitional control (e.g., “we have no choice,” “it's not an option to not use it”), because it was mandated by the organization, because some information was accessible only electronically, and generally because EMR and CPOE were believed to have become “as essential as … carrying a pen and a stethoscope,” with physicians perceived to be “reliant on the EMR now.” Some factors precluded volitional use, according to physicians. Mentioned factors were a lack of computer stations, unavailability of features or information in the partial EMR at Hospital 1, and the EMR being unavailable (“But when it's down, it is down. And nothing is available.”) Some specific actions, such as addressing CPOE allergy warnings, were also perceived as uncontrollable. Few perceived EMR and CPOE use as up to them, although a third of physicians in Hospital 2 noted that they were given the choice to dictate admission and discharge notes instead of entering them manually.

3.9. Control beliefs: Self-efficacy

Physicians reported numerous perceived barriers that might have limited their ability to use EMR and CPOE. They included perceived hardware and software barriers (e.g., non-functioning remote access software, Mac-PC incompatibility, slow operating system); system slowness and delays; environmental barriers (e.g., “The only problem now you have is finding a computer”); lack of typing proficiency; lack of understanding of how to use the system, which was perceived to be difficult to use and unintuitive; insufficient time to use the system or to learn to use it; and forgetting how to use the system after some time had passed.

Physicians also reported perceived factors that might have made it possible or easier to use EMR and CPOE. Having access to a computer and the remote access gateway were often mentioned. Physicians believed that initial training and technical support facilitated use (e.g.,

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"[support staff] wore red vests, and they were on the floors and could be summoned by, you know, 'Hey, could you come over and help me?' if they were right within earshot, or you could call, and someone would come up and help you"). Post-implementation nearly half the physicians said they used a support helpline or helpdesk to facilitate their use. Other physicians said that they sought support from colleagues. Some preferred those informal helpers to the dedicated technical support staff: "probably more important have been colleagues sharing tips and kind of best practice or best use. Those are the most useful…." Other commonly mentioned perceived facilitators were environmental (e.g., having a broadband connection), technological (e.g., a customizable, consistent format), and individual (e.g., learning to use the system, motivation and adventurousness, and abilities including typing skill).

3.10. Other beliefs

Among the many beliefs about the system itself (rather than about its use), the following were most commonly mentioned. 50% of physicians noted the need for fit between the system and other elements of the work system (e.g., "you really need to customize the technology to the individual … department"), the perceived lack of fit (e.g., "it doesn't work how doctors think, basically"), and the perceived requirement to adapt in order to achieve fit (e.g., "I have to kind of change my workflow to accommodate it, rather than the other way around"). Some perceived that the system was intuitive and had other positive usability aspects, but many more described specific perceived problems as well as general usability limitations (e.g., "This is stupidly designed. This is designed by someone who is not actually taking care of patients").

Overall, physicians at both hospitals spoke favorably about system implementation, although some at Hospital 2 believed that CPOE was implemented with problems (e.g., too hastily, without first establishing nurses' roles in the ordering process). Physicians also mentioned what they believed to be specific implementation problems, including strained physician-nurse relations, major workflow changes, and unplanned hospital expenditures. Physicians gave detailed responses about their perceptions of the roll-out, initial training and technical support, management support and commitment (most believed that their hospital was very supportive and committed), user involvement (some believed they were under-involved whereas others were content with a low level of involvement), post-implementation modifications to the system, and interactions with the vendor.

Finally, physicians described the EMR and CPOE-use-related beliefs and behaviors of their colleagues, including shortcuts and work-arounds such as phoning nurses from within the hospital and having them enter orders, thus taking advantage of nurses' obligations to put in verbal orders given over the phone. Unfortunately, space limitations preclude more thorough discussion of this and other categories of "other beliefs" in the present paper.

4. Discussion

The elicited physician beliefs about EMR and CPOE summarized in the preceding text suggest several policy and design goals.

EMR and CPOE must support the outcomes deemed important by physicians. Although those include organizational benefits such as billing efficiency, physicians saw the benefit of EMR and CPOE in terms of supporting the ease and quality of personal performance [40]. Findings from the present study suggest how design and policy can support performance. Improved ease of performance begins with improved access, particularly remote connectivity, which requires multiple, networked computers and a fast and secure remote access gateway for access from home. Once connected, a great deal of information must be easy to retrieve, easy to find, and immediately accessed. This is not possible if information is spread across many screens, especially in a way that does not match the physician's mental model of where things should

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be located. Some information important to patient care is not available because of lacking connectivity between hospitals (or clinics), and this, along with barriers to accessing available information, can jeopardize situation awareness and the ability to stay informed.

Not being properly informed might also be caused by some of the practices of use, such as laboratory tests that arrive late or when physicians copy and paste entire notes rather than taking extra time to replicate only the most vital information, a practice that may also perpetuate errors. It may be that physicians are unaware of the way that their use of the system affects others and it is also likely that organizational (e.g., time pressure) and technological (e.g., low usability) factors "force" delayed uploading of results and their interpretations, copy and paste short-cuts, and similar behaviors. A combination of how EMR and CPOE systems are designed and how they are used will also affect whether communication between clinicians is improved or worsened. To avoid problems, those systems will have to be designed and implemented as communication tools, not simply as databases or repositories of information [11,13].

Physicians recognize the benefits of EMR and CPOE for legibility, and readily link this to better and safer care outcomes. At the same time, the burden and time inefficiency of data entry are seen as major disadvantages, suggesting the importance of "smarter" and more intuitive data entry interfaces and perhaps voice recognition. That physicians resent doing data entry and feel that their time could be better spent in other ways raises the question of how might certain data entry steps be allocated to other human or machine agents. Certainly, some unnecessary steps, perhaps even those related to clicking through an overabundance of false-alarm alerts, can be reduced through better design [6,41,42]. The finding that physicians perceive EMR and CPOE as threats to productivity, efficiency, and patient outcomes implies that physicians are not simply being resistant to change [43], but are truly concerned about consequences central to their work. Yet, there are ways in which EMR and CPOE improve outcomes and it pays to emphasize this fact to physicians, to provide feedback about observed benefits of using the system [2,4], and to replicate the circumstances that make improved outcomes possible.

Conveying the importance of using EMR and CPOE is something that should be done by entities that have import to physicians, and that includes not only hospital (or clinic) administration, but also patients and political entities, as well as professional organizations to which physicians belong. Whereas some physicians thought that patients encouraged EMR and CPOE use, other physicians thought that patients were unaware; if patients truly have strong opinions about their physician using EMR and CPOE, those opinions may be poorly conveyed. In general, how the benefits of EMR and CPOE use are communicated is an important question [44]. Communication might appeal to physicians' existing sense of professional and moral responsibilities to use EMR and CPOE systems. Perhaps it is even possible to instill a new culture wherein the role of every ethical physician—and not just the younger, technologically savvy ones—is to use EMR and CPOE effectively. Of course, organizations must consider whether the imposition of new technology is always ethical (i.e., moral), especially because so much of the system's use is not perceived to be voluntary. Mandatory use may take away physician's autonomy [45]. A pressing moral issue, consistent with other EMR research [10,46], is the actual and perceived security of private information. Many of the physicians in this study were concerned about safeguarding data and most were faithful but not certain that data were safe; this is a knowledge gap to be filled during orientation and continued communication.

Facilitators and barriers to using IT can profoundly shape both IT acceptance and the end user's ability to actually use IT [47]. Physicians perceived so many necessary facilitators and so many barriers from so many sources that one thing is clear: design and policy solutions must aim for fit between all of the components of the *whole* work system [48], from the physical environment

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of work stations and walls (i.e., connectivity), to organizational factors such as provision of technical support and other resources, to the content and timing of tasks, to technological capability and usability, to cognitive and motivational personal factors, and more [49,50]. It may be that the needs of physicians in the actual context of use differ from what an administrator or designer perceives to be needed. Take for instance the unexpected importance of tips shared between colleagues. Numerous comments about the enabling power of such tips raise the possibility of supplementing formal training with a mailing list, message board, or other forum through which colleagues can share tips and best practices.

4.1. Further research

A crucial next step is to select from the beliefs elicited in the present study the ones that are most salient (i.e., commonly mentioned or most important to physicians) and to formulate hypotheses about the mechanism by which those beliefs might shape acceptance, behavior, and other key outcomes such as patient safety. Next, survey measures should be developed and then implemented in a large, representative sample to quantitatively assess how strongly individuals hold particular beliefs and to what extent variations in beliefs are associated with variations in actual acceptance, use, and other outcomes. Large-sample research will also address the issue of generalizability, especially when the sample contains multiple sites (clinics, hospitals), professionals (attending and resident physicians, nurses, pharmacists), and technologies (EMR, CPOE, decision support software, bar-coded medication administration). In the area of behavioral psychology, there exist several excellent sources for survey research on behavior-shaping beliefs and for using research results for practical purposes such as changing beliefs or promoting behavior [32,33].

A mid-term goal of continued research on beliefs about health IT use is to develop a theoretical model that helps to explain and predict health IT acceptance and use. Studies such as this will allow such a theory to be contextualized to health IT, lending it an advantage over theories borrowed from other settings such as finance or personal web use [24,28,51,52]. Of course, it will become necessary to compare any new theory to the established, context-nonspecific theories that have been applied to health IT. The fastest growing, if not now the leading, context-nonspecific theory of IT acceptance and use in the health informatics discipline is the Technology Acceptance Model (TAM) [24,53]. TAM is also a belief-based behavioral theory and therefore could serve as an excellent comparison for judging the usefulness of a new theory of health IT acceptance and use.

4.2. Study limitations

The present study was limited in several ways. First, a small sample size, although appropriate for qualitative interview research, limits the ability to generalize the discovered beliefs to the broader population of physicians using EMR and CPOE, especially with systems or in organizations that are dissimilar from those in this study. However, to quote Ash and colleagues' comment on their own qualitative study of health IT, “the result may not be generalizable in a quantitative methods sense, but they should be both representative and credible in the qualitative sense” [54]. Second, although this study determined the nature and commonness of beliefs, it could not determine to what extent beliefs were correlated with actual acceptance and use of EMR and CPOE. Subsequent survey research, as suggested in the preceding section, can also address this limitation. Third, the study included only attending physician participants, despite the importance of understanding nurses', pharmacists', residents', and others' beliefs about using EMR and CPOE.

Further research should both overcome the limitations of the current study and further develop research, theory, and practice on health IT use. Such research might include survey-based work to measure the strength of health IT use beliefs and to test hypotheses about (causal)

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relationships; elaborating the nature of groups differences (e.g., between professionals, hospitals, inpatient vs. outpatient); more thorough analysis of which beliefs are most salient, most strongly held, and most likely to shape use behavior; assessment of how beliefs change over time; analysis of how design and implementation affect post-implementation beliefs; and specifying design plans, rather than merely goals, on the basis of discovered beliefs, with the aim of better supporting clinical cognition with health IT [40,55]. A final direction for the future must be the development and subsequent use of health IT theory; this is both an important follow-up to beliefs elicitation studies and a generally beneficial direction for the field of medical informatics.

5. Conclusion

This study identified many different beliefs that physicians have about using EMR and CPOE. Those beliefs commonly identified by a large number of physicians are likely to shape whether and how those and other physicians use EMR and CPOE for inpatient and outpatient care. The study also sets up and encourages further work to be done, including further development of surveys of clinician perceptions of health IT [56,57], and the development of valid and practical theories of health IT use that are mindful of the unique health care context [2,52,58]. It should be noted that although this study was interested in factors related to health IT acceptance and use, this does not imply that acceptance and use should be the sole or even primary goals for the informatics community. An additional goal must be to ensure that health IT, in interaction with the greater work system, supports the cognition and work performance of clinicians [40, 49]. It is quite likely that the same design issues that influence acceptance and use also influence IT-assisted work performance and, consequently, outcomes such as quality and safety.

Finally, and very importantly, there is no doubt that design- and policy-mediated solutions developed on the basis of elicited beliefs can have profound beneficial effects on safety, quality, and other outcomes. With peak interest in implementing EMR, CPOE, and other health IT in the US and worldwide and federal funding for this, knowing and acting on the beliefs associated with clinician use of those technologies is as essential as ever.

Summary Table

What was already known on the topic

• The success of health information technology (IT) depends a great deal on individual-level responses of clinician end users; those responses include acceptance/rejection of the IT and how (even whether) clinicians use the IT.

• The success of electronic medical records (EMR) and computerized provider order entry (CPOE) has been stalled in part by individual-level reactions to those health ITs.

• Behavioral theory asserts that decisions to accept and use technology are based on internal psychological variables, i.e., “beliefs.” However, no study has ever reported a full set of beliefs that might shape EMR and CPOE use in the unique health care context.

What this study added to our knowledge

• The study identifies the beliefs about using IT that are specific to the unique context of physicians using EMR and CPOE for inpatient and outpatient care. Those beliefs fall into broad categories such as “performance outcome effects,” “entities that approve or encourage use,” “facilitators,” and “barriers.”

• Within the above categories are context-specific beliefs, for example, beliefs about the ability of EMR and CPOE to improve legibility, about the problem of “garbage-in, garbage-

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out," and about the benefits of sharing tips on EMR and CPOE use between colleagues. The details of such behavior-shaping beliefs provide guidance to both practitioners and researchers.

• Having identified a broad set of detailed beliefs deemed relevant to physicians using EMR and CPOE for patient care lays the foundation for developing a contextualized understanding of health IT use that competes with and may outperform leading context-nonspecific theories used by health IT researchers.

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Table I

Types and definitions of behavior-shaping beliefs and questions used in the study to elicit those beliefs.

Belief type and definition	Interview questions used to elicit beliefs
Behavioral beliefs Perceptions of outcomes, desirable or undesirable, that are likely to occur as a result of behavior. Outcomes can be *Instrumental* ("cognitive") or *Affective* ("emotional").	• "What do you believe are the advantages of using [the system]?" • "What do you believe are the disadvantages of using [the system]?" • "Do you have any other experiences or beliefs about the costs or benefits of using [this system]?"
Normative beliefs Perceptions of *external* pressure from important others who encourage or discourage the behavior and *personal norms* about how the behavior fits with one's self-identity and moral values.	• "Are there any individuals or groups who would approve of or encourage you using [the system]?" • "Are there any individuals or groups who would disapprove of or discourage you using [the system]?" • "Is there anything else you associate with other people's views about you using [the system]?" • "What comes to mind when you think of those individuals who use [the system]?" • "What adjectives or demographics describe individuals who use [the system]?" • "What are the ethical/professional implications of using [the system]?" • "What personal convictions (values, morals, principles) do you have about using [the system]?"
Control beliefs Perceptions of the degree to which the behavior is volitional (*controllability*) and one's ability to successfully carry out the behavior (*self-efficacy*).	• "What factors or circumstances would enable you to use [the system]? • "What kind of factors, circumstances, or conditions would facilitate or allow you to use [the system]?" • "What factors or circumstances would make it difficult or impossible for you to use [the system]?" • "Are there any other issues that come to mind when you think about being able to or not being able to use [the system]?
Other beliefs Other perceptions that might affect behavior, including beliefs about the *implementation* and about the *object* (e.g., the technology itself).	• "What thoughts or feelings do you have about the way that [the system] was implemented in your hospital?" • "Did you have any concerns about the changes brought about by the implementation of [the system]?" • "What thoughts or feelings do you have about management's commitment to and support of [the system]?" • "What thoughts or feelings do you have about your involvement regarding decisions about [the system]?"

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Table II

Study sample characteristics.

Specialty (number of participants)	**General medicine (10), Anesthesiology (2), Psychiatry (2), Obstetrics/Gynecology (2), Rheumatology (1), Cardiology (1), Orthopedics (1), Ophthalmology (1)**
Males / Females	15 / 5
Age	
30 – 39	6
40 – 49	7
50 – 59	6
60+	1
Average years in job (range)	15 (4 – 32)
Average years computer experience (range)	20 (10 – 30)
Comfort with general technology (range)[a]	7.6 (3 – 10)
Comfort with hospital technology (range) [a]	7.7 (5 – 10)

[a] on a 10-point scale (1 = extremely uncomfortable, 10 = extremely comfortable)