

Same organization, same electronic health records (EHRs) system, different use: exploring the linkage between practice member communication patterns and EHR use patterns in an ambulatory care setting

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ABSTRACT

Objective Despite efforts made by ambulatory care organizations to standardize the use of electronic health records (EHRs), practices often incorporate these systems into their work differently from each other. One potential factor contributing to these differences is within-practice communication patterns. The authors explore the linkage between within-practice communication patterns and practice-level EHR use patterns.

Design Qualitative study of six practices operating within the same multi-specialty ambulatory care organization using the same EHR system. Semistructured interviews and direct observation were conducted with all physicians, nurses, medical assistants, practice managers, and non-clinical staff from each practice.

Measurements An existing model of practice relationships was used to analyze communication patterns within the practices. Practice-level EHR use was defined and analyzed as the ways in which a practice uses an EHR as a collective or a group—including the degree of feature use, level of EHR-enabled communication, and frequency that EHR use changes in a practice. Interview and observation data were analyzed for themes. Based on these themes, within-practice communication patterns were categorized as fragmented or cohesive, and practice-level EHR use patterns were categorized as heterogeneous or homogeneous.

Practices where EHR use was uniformly high across all users were further categorized as having standardized EHR use. Communication patterns and EHR use patterns were compared across the six practices.

Results Within-practice communication patterns were associated with practice-level EHR use patterns. In practices where communication patterns were fragmented, EHR use was heterogeneous. In practices where communication patterns were cohesive, EHR use was homogeneous. Additional analysis revealed that practices that had achieved standardized EHR use (uniformly high EHR use across all users) exhibited high levels of mindfulness and respectful interaction, whereas practices that were furthest from achieving standardized EHR use exhibited low levels of mindfulness and respectful interaction.

Conclusion Within-practice communication patterns provide a unique perspective for exploring the issue of standardization in EHR use. A major fallacy of setting homogeneous EHR use as the goal for practice-level EHR use is that practices with uniformly low EHR use could be considered successful. Achieving uniformly high EHR use across all users in a practice is more consistent with the goals of current EHR adoption and use efforts. It was

found that some communication patterns among practice members may enable more standardized EHR use than others. Understanding the linkage between communication patterns and EHR use can inform understanding of the human element in EHR use and may provide key lessons for the implementation of EHRs and other health information technologies.

INTRODUCTION

With unprecedented investments in electronic health records (EHRs) taking place, healthcare is entering a time in which improved understanding of EHR use is more critical than ever. Previous research has focused on understanding adoption rates of EHRs,^{1,2} how EHRs influence fundamental outcomes such as the cost and quality of healthcare delivery,^{3–7} and how they reshape organizational culture⁸ and clinical workflow^{9,10} in both intended and unintended ways.¹¹ A growing literature providing in-depth, rich accounts of EHR use is generating valuable insights into how EHRs are being used by healthcare providers in healthcare delivery processes.^{12–14} This research, coupled with reports from national health information technology (HIT) leaders,^{15–17} brings into focus a need for additional in-depth understanding of the social underpinning, or the ‘human element’ involved in EHR acceptance, implementation, and use.

At the same time, healthcare delivery systems that have implemented EHR systems are struggling with how to benefit from EHR use by physicians, nurses, and other healthcare team members. Research linking EHR use with safer, higher quality, more efficient care delivery exists,¹⁷ but challenges remain in terms of achieving larger-scale benefits through EHR use.¹⁸ One of the barriers preventing healthcare delivery systems from benefiting from EHR use is large variation in how medical professionals use this HIT. For example, physician preferences on clinical documentation can differ greatly within the same practice, creating conditions where some physicians opt to interact directly with the EHR, while others take a more indirect approach to EHR use, instead relying on nurses and/or medical assistants to document the clinical encounter in the EHR system. This example illustrates the kinds of challenges that healthcare delivery systems face with regard to how much variation should be encouraged or permitted with EHR use. Given



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what we know about differences in how physicians think about their work¹⁹ and how they make medical decisions,²⁰ to what extent should healthcare delivery systems seek to minimize differences in EHR use? On the other hand, to what extent should healthcare delivery systems accommodate differences in EHR use among physicians and other healthcare professionals given that such differences often make it difficult to benefit from EHR use at a system level? The tension between system-level goals for EHR use and individual-level differences in cognition and decision-making processes poses a real challenge for healthcare delivery systems, particularly in terms of achieving harmony between quality of care, patient satisfaction, and meaningful EHR use.

Little is known about how communication patterns are associated with EHR use, particularly at the practice level. We know from a socio-technical perspective that the use of information technologies influences human behavior and that, at the same time, human behavior influences the structures and roles of information technologies.^{21–23} From this perspective, we can assume an ongoing co-evolution between EHRs and the people that use them. In this study, we explore the linkage between within-practice communication patterns and practice-level EHR use. Additionally, this research seeks to contribute new understanding to the issue of EHR use standardization. We define standardized EHR use as EHR use that is uniformly high across all users within a practice. This study describes types of within-practice communication patterns that are associated with homogeneous and heterogeneous patterns of practice-level EHR use and with more and less standardized EHR use. Because of the emphasis of complex adaptive systems (CASs) theory on examining the interdependencies among individuals in complex social systems, we use a CAS perspective to frame our study. This study seeks to contribute new knowledge of the ‘human element’ critical to achieving and sustaining effective use of EHRs and to support physician practices’ goals of delivering high-quality technology-enabled care to patients.

THEORETICAL FRAMEWORKS

CAS theory

CAS theory aims to understand the structure and dynamics of complex systems. CASs are made up of interdependent diverse agents that self-organize and co-evolve with their environments.^{24–25} CAS theory has been widely used to study healthcare delivery organizations,^{26–28} information systems^{29–32} and computer science^{33–34} are additional research areas where CAS theory has been applied to understand complex social phenomena.

We highlight two aspects of CASs. First, individuals in CASs are diverse, and when they interact with each other they exchange information and learn.³⁵ Diversity among individuals has been linked to positive system traits such as novelty, creativity, and innovation.³⁶ Second, an important aspect of CAS theory is the notion that understanding the interdependencies among agents (eg, individuals) is critical to both understanding a system and improving how it functions.³⁷ Improving how the parts of a system interact with each other is critical to achieving system-level objectives. Thus, a concerted effort to understand how practice member communication patterns are associated with EHR use could generate insights helpful in designing, implementing, and managing EHR systems in ways that support the complex work of physicians, nurses, and other healthcare professionals.

We use CAS theory to study the linkage between within-practice communication patterns and practice-level EHR use.

While a physician’s practice of medicine is a highly specialized cognitively intensive job, the process of delivering healthcare to patients is about coordinating knowledge, expertise, and skills of a number of diverse healthcare professionals. For this reason, more needs to be known about the social landscapes on which EHRs are used and how these social landscapes are associated with EHR use.

Model of practice relationships

To study the communication patterns in the practices, we used an existing model of practice relationships.³⁸ The model is a result of the key findings from a set of large, comprehensive and mixed methods studies conducted in primary care practices. In these studies, primary care practices where relationships among practice members were characterized by trust, diversity, mindfulness, heedful inter-relation, respectful interaction, social and task relatedness, and rich and lean communication delivered preventive care to patients more consistently than practices where these characteristics were not observed. The model derived from this set of studies describes an association between practice relationships and practice performance in terms of both clinical and non-clinical outcomes. We selected this model for studying within-practice communication patterns because of its consistency with the theoretical frame used in this study and because of its consideration for non-clinical outcomes (eg, EHR use). Although the model was developed on the basis of work conducted in primary care settings, it provides a basis for conceptualizing practice member relationships across a variety of healthcare delivery settings.

METHODS

Study design

We conducted a multi-method qualitative study to explore the linkage between within-practice communication patterns and practice-level EHR use. Because the seven characteristics of practice relationships included in this study are highly nuanced and complex social behaviors, and because we sought to obtain a more grounded understanding of practice-level EHR use, a qualitative approach was appropriate.³⁹ CAS theory informed our study by directing our attention to the communication patterns among individuals in the practices (interdependencies) and on the differences (diversity) in how practices used the same EHR. The model of practice relationships guided our investigation of the communication patterns in the practices. We performed in-depth data collection in six purposefully selected practices operating within the same outpatient multi-specialty group. Using theoretical sampling is appropriate when studying less mature phenomena and when study of the average case is likely to produce less rich information.⁴⁰ We selected three primary care practices and three specialty practices to explore the association between communication patterns and EHR use in both generalist and specialist settings. Data collection instruments were adapted from existing validated instruments and were informed by relevant literature. The first author spent approximately 4 weeks in each practice collecting data on communication patterns and EHR use. Semistructured interviews were conducted with all practice members including physicians, nurses, medical assistants, clerical staff, and business and clinical managers. Field notes from direct observation provided additional data. The following sections describe the field site organization including the EHR product, the six practices selected for study, and the data collection and analysis procedures used in this study.

Research site

Our field site is a multi-specialty ambulatory care organization in Texas. HealthGroup (pseudonym) serves a wide variety of patients, providing both primary and specialty care. The group includes over 120 physicians and over 500 employees. HealthGroup has 24 medical specialties operating in 17 locations. Its patients are primarily Medicare or commercially insured. The group is associated with one hospital that is part of a larger multi-hospital system, but its patients are admitted to the more than 10 hospitals in the surrounding community. HealthGroup implemented its EHR system 6 years before the start of data collection, providing an opportunity to study EHR use after the practices had used the technology for an extended period of time and had developed observable patterns of EHR use. According to the physician and administrative leadership at HealthGroup, the organizational goals for EHR implementation were as follows: (1) to improve information timeliness and availability to geographically dispersed users; (2) to improve capacity to compile patient and medical delivery data over time in order to learn about the population of patients cared for by HealthGroup; and (3) to provide physicians with alternative tools for clinical documentation.

The EHR system

The EHR system at HealthGroup was adopted by the physician board and was adopted primarily as a clinical, as opposed to an administrative, tool. At the time, it was one of the leading ambulatory products on the market (and remains so today); it included a full suite of features giving physician practices at HealthGroup an opportunity to become sophisticated EHR users. The EHR system could be used to document phone notes, update patient medication lists, order laboratory tests and x-ray or other imaging examinations, document clinical visits using templates and/or free text fields, generate patient panel reports, input laboratory results and prescriptions, and track patient data over time. Practices had the opportunity to work with HealthGroup’s EHR support staff to develop tailored templates for clinical documentation. Physicians could use the EHR system to communicate with other physicians and nurses within HealthGroup, with pharmacies via an e-prescribing feature, and with patients via secure email. HealthGroup’s internal IT department provided initial as well as on-demand EHR training and support to the practices. Although both the physician leadership and the executive administration promoted adopting the EHR system, the final decisions about how to implement and use it were left up to the individual practices.

We observed 21 physician–nurse teams (100% participation) across six practices. Selecting six practices within the same organization using the same EHR system allowed us to isolate and focus on studying practice-level factors of EHR use as opposed to technological- or organizational-level factors. Summary details of the practice sites are provided in table 1.

Table 1 Summary detail of practice sites

Practice	Physicians	Clinical staff	Non-clinical staff	Total practice members
Family medicine A	3	7	6	16
Family medicine B	3	7	4	14
Family medicine C	3	6	4	13
Specialty practice A	2	4	1	7
Specialty practice B	4	7	4	15
Specialty practice C	6	7	4	17

Data collection

Before data collection, institutional review board approval for research involving human subjects was received from the first author’s institution. The first author spent approximately 4 weeks collecting data in each field site—a total of approximately 720 h in the field. The first week at each practice was dedicated to non-participant observation. Semistructured interviews were conducted in the second, third and fourth weeks. Non-participant observation was ongoing throughout the 4 weeks. We used semistructured interviews and non-participant observation techniques to collect data about communication patterns and EHR use patterns. To obtain in-depth, rich accounts in the data, we used an ethnographic interviewing approach.⁴¹ All members of each practice agreed to be interviewed. Interview questions were developed on the basis of relevant HIT, information systems, and organizational behavior literature.¹ Interviews were audio recorded and lasted approximately 30–45 min. Box 1 provides examples of the types of questions asked in the interviews.

To supplement interviews with the practice members, we interviewed HealthGroup’s Chief Information Officer, Chief Medical Director, Associate Director of the Board, and several members of HealthGroup’s IT staff. These supplemental interviews were focused on helping us gain a broader understanding of the history surrounding the EHR system in this organization.

We developed an observation template by modifying an existing template previously used in researching clinical settings.⁴² Observations focused on detecting patterns of practice member communication patterns and EHR use, as well as on collecting data on the physical layout and work flow of each practice. Observations were performed in all areas of each practice, including nursing stations, patient reception areas, support staff work areas, and employee break rooms. Additionally, we shadowed practice members from each category of clinical staff as they worked with the EHR. The first author received clinical support staff EHR training from HealthGroup’s EHR training staff to better understand observations made during the study. Researcher field notes were written each day to capture data from the field observations.

During data collection, the research team conducted weekly meetings to discuss observations from the field. These meetings lasted between 2 and 4 h and were used to (1) facilitate critical reflection on the observation process and the methods, (2) discuss preliminary findings or early patterns in the data, and (3) address study-related issues that developed during the practice observation.

Analytical approach

To analyze variations in practice-level EHR use and within-practice communication patterns, we used a qualitative approach.^{43–46} All authors were involved in analyzing the data. To reach an appropriate level of internal validity, we used multiple sources of data.⁴⁷ Interview transcripts and observation field notes were analyzed in three steps: (1) theme formation; (2) theme matching along dimensions of communication patterns and EHR use behaviors; and (3) theme comparison across practices.⁴⁸ Two authors independently reviewed the interview transcripts and field notes, making methodological, theoretical memos and preliminary interpretations. Individual researcher interpretations were followed by discussions between researchers whereby identified themes were further refined and

¹The interview guide and observation template are available from the first author upon request.

Box 1 Types of questions included in interviews**Questions related to EHR use**

Describe how you use the EHR in your work.

What EHR features do you use often/sometimes/rarely?

Did you find it easy/difficult to learn how to use the EHR?

How often do you learn new things about the EHR?

What kinds of things do you like about the EHR?

What kinds of things do you dislike about the EHR?

Has the EHR changed the way you practice medicine (do your job)? If so, how?

How have you modified or tailored the templates that you use in the EHR? If so, how?

What do you think is unique about how you use the EHR?

How often do you change the way you use the EHR?

To what extent do you use the EHR to communicate with others in this practice? Outside this practice?

Questions related to communication patterns

Describe the communication patterns between the physicians in this practice.

Describe the communication patterns between the nurses in this practice.

Describe the communication patterns between the non-clinical staff in this practice.

How do the physicians relate with the clinical and non-clinical staff in this practice?

Do people in this practice consider your input when making decisions?

Do you feel like you can voice your opinion to others in this practice even if it may be unpopular?

Do you understand how your role fits into the work of this practice?

Do you think people in this practice understand how their actions affect your work?

How are messages communicated in this practice? Face-to-face, email, phone, etc?

Do people in this practice socialize outside of work?

Describe a time when an unexpected or surprising event happened in this practice. Talk with me about what happened and pay specific attention to how the members of this practice worked together (or didn't) to respond to the unexpected event and resume functioning of the practice.

new themes were co-generated.⁴⁴ All themes generated during data analysis were developed through a process of articulating a unifying idea that represented interpretations from multiple data points in the interview and observation data. Conceptual labels were assigned to organize themes according to a common thread among ideas. At each step, themes were refined whereby similarly labeled ideas were combined into themes and given more general labels. Iterations of this process provided a platform for comparing communication patterns and EHR use within each practice and then between the six practices.⁴⁰

Within-practice communication patterns were analyzed using an existing model of practice relationships.³⁸ Two of the three authors were involved in developing this model and all three authors have experience applying this model in research. For each practice, we analyzed the communication patterns among practice members on the basis of an assessment of the presence, or lack thereof, of seven characteristics: (1) trust; (2) diversity;

(3) mindfulness; (4) heedful inter-relation; (5) respectful interaction; (6) social and task relatedness; and (7) rich and lean communication. These characteristics are discussed in detail in the original work. We briefly summarize these characteristics in box 2.

We coded the interview and observation data for each of the seven characteristics using the definitions provided in the original research³⁸ as well as the discussions and examples of how these characteristics appear in clinical practice.³⁸, pp. 460–3 To be categorized as high on a characteristic, more than 50% of respondents in a particular practice needed to have made statements consistent with the definitions of the characteristics, and the examples of practical applications in the interviews and observation data needed to be in agreement with the interview data with regard to the degree to which a particular characteristic was present in the practice. To be categorized as moderate on a characteristic, between 25% and 50% of respondents needed to have made statements consistent with the definitions of the characteristics, and the examples of practical applications in interviews and the observation data needed to be in agreement with the interview data with regard to the degree to which the characteristic was present in the practice. To be categorized as low on a characteristic, fewer than 25% of respondents needed to have made statements consistent with the definitions of the characteristics, and the examples of practical applications in interviews and the observation data needed to be in agreement with the interview data with regard to the degree to which a particular characteristic was present.

Box 2 Seven characteristics of practice relationships³⁸**Trust**

- ▶ The willingness of an individual to be vulnerable to another individual.

Diversity

- ▶ Differences in individual perspectives of the world. Diversity is important for problem solving and learning.

Mindfulness

- ▶ Openness to new ideas, new ways of doing things; fully engaged presence; rich discriminating awareness to detail; seeking novelty even in routine situations.

Heedful inter-relation

- ▶ Interaction in which individuals pay attention to the task at hand (their job) and at the same time are sensitive to the way their actions affect the group.

Respectful interaction

- ▶ Honest, self-confident, and appreciative interaction among individuals that creates new meaning.

Social and task relatedness

- ▶ Social relatedness is characterized by non-work-related conversations and activities.
- ▶ Task relatedness is characterized by work-related conversations and activities.

Rich and lean communication

- ▶ The use of an effective mixture of communication channels for transferring messages.
- ▶ Face-to-face conversation is a form of rich communication and is effective when information being transferred is highly uncertain or ambiguous. Impersonal documents are lean channels of communication and are most effective when information being transferred is clear and non-threatening.

We then categorized the overall communication patterns in each practice by evaluating the extent to which the seven characteristics were present/not present as a collective set. The categories, fragmented and cohesive, emerged during the data analysis because of the extent to which they conceptually captured the basic nature of the communication patterns among practice members in all six practices. For within-practice communication patterns to be categorized as cohesive, a practice needed to be high on at least four of the seven characteristics. For within-practice communication patterns to be categorized as fragmented, a practice needed to be low or moderate on at least four of the seven characteristics.

Because the work of physicians and nurses at HealthGroup was highly interdependent, we categorized EHR use as a function of the physician–nurse team. Within each practice, we categorized the EHR use by each physician–nurse team as high, medium or low on the basis of the following three criteria: (1) degree of feature use; (2) level of EHR-enabled communication with others; and (3) the frequency that EHR use changed within the team.

‘Degree of feature’ use was defined as the extent to which physician–nurse teams used the available features of their EHR. For example, physician–nurse teams that still used paper medical records or only used the EHR system for basic clinical documentation of patient encounter were categorized as having low feature use. Physician–nurse teams that used the EHR system for checking laboratory output, reviewing previous clinical documentation, writing letters to patients, faxing prescriptions to pharmacy, analyzing clinical information via flow sheets, and tailoring clinical documentation templates for own medical practice were categorized as having high EHR use. ‘Level of EHR-enabled communication with others’ was defined as the tendency of a physician–nurse team to use the EHR system to communicate with other healthcare professionals (including each other) versus non-EHR channels to communicate. For example, physician–nurse teams that rarely used the EHR system to communicate information to others, opting instead for face-to-face communication or talking by telephone, were categorized as having a low level of EHR-enabled communication. Physician–nurse teams that almost exclusively used the EHR system to communicate with each other and with other healthcare professionals were categorized as having a high level of EHR-enabled communication. ‘Frequency that EHR use changed within the team’ was defined as the likelihood that a physician–nurse team would alter their use of the EHR system on the basis of new information—usually provided as knowledge gained from peer physician–nurse teams about their use of the EHR system or through the roll out of new EHR system features, which in this organization occurred approximately every quarter or semiannually. For example, physician–nurse teams that either rarely or never changed the way they used the EHR system on the basis of input from peers or the roll out of new features were categorized as having a low frequency of EHR use change. Physician–nurse teams that tended to incorporate new knowledge gained from peers about EHR use and/or newly rolled out EHR features into their EHR use were categorized as having a high frequency of EHR use change.

For physician–nurse team EHR use to be categorized as high, the team needed to be high on all three criteria. For EHR use to be categorized as low, the team needed to be low on all three criteria. We categorized EHR use as medium for teams that displayed a combination of high and low on these criteria or that were medium on all of these criteria. Table 2 illustrates this categorization.

We used the EHR use categorizations of each physician–nurse team in a practice to analyze the overall EHR use in each practice. Practice-level EHR use was further categorized as homogeneous in practices where all physician–nurse teams displayed the same level of EHR use (regardless of level). Practice-level EHR use was categorized as heterogeneous in practices where physician–nurse teams displayed different levels of EHR use.

We then analyzed the data to identify associations between within-practice communication patterns and standardized EHR use (uniformly high levels of EHR use in a practice). Uniformly high levels of EHR use are preferred over most other patterns of EHR use in healthcare delivery systems that are seeking to deliver high-quality technology-enabled care to patients and meet meaningful use criteria. Insights into how within-practice communication patterns are associated with standardized EHR use are particularly salient in the current EHR adoption and use efforts.

RESULTS

Within-practice communication patterns

Data analysis revealed variation in within-practice communication patterns across the six practices. Following in-depth analysis describing the extent to which the seven characteristics were present in each practice, communication patterns in family medicine A, family medicine B, and specialty practice C were found to be fragmented. Communication patterns in family medicine C, specialty practice A, and specialty practice B were

Table 2 Summary of electronic health record (EHR) use categories

EHR use category	Definition
High	<p>Users in this category display high integration of EHR use with work practices. Teams in this category exhibit the following items:</p> <ul style="list-style-type: none"> High feature use (including <i>at least two</i> of the following features) <ul style="list-style-type: none"> Reports, flow sheets and/or other tracking and trending features EHR-generated patient literature Macros/quick text feature High EHR-enabled communication with others inside practice High EHR-enabled communication with others outside practice High EHR-enabled communication with pharmacies Frequently changes EHR use as new features rolled out or learned
Medium	<p>Users in this category display moderate integration of EHR use with work practices. Teams in this category can be divided into two types:</p> <ul style="list-style-type: none"> Users that exhibit high use of <i>some but not all</i> of the items in the high user category Users that exhibit moderate use of all or most of the items listed. This user type is articulated below: <ul style="list-style-type: none"> Moderate feature use (including at least one of the following features) <ul style="list-style-type: none"> Reports, flow sheets and/or other tracking and trending features EHR-generated patient literature Macros/quick text feature Moderate EHR-enabled communication with others inside practice Moderate or sporadic EHR-enabled communication with others outside practice Moderate EHR-enabled communication with pharmacies Rarely or sometimes changes EHR use as new features rolled out or learned
Low	<p>Users in this category have low integration of EHR use with work practices. Teams in this category exhibit the following items:</p> <ul style="list-style-type: none"> Low/minimal feature use (eg, minimal documentation) Low/minimal EHR-enabled communication with others inside practice Low/minimal EHR-enabled communication with others outside practice Low/no EHR-enabled communication with pharmacies Rarely changes EHR use as new features rolled out or learned May have high reliance on nursing staff to complete EHR-related work tasks May use paper records as primary documentation source

found to be cohesive. Table 3 summarizes these findings and provides quotes from the data that exemplify the communication pattern in each practice.

Practice-level EHR use

Analysis revealed differences in EHR use across the six practices. Following in-depth analysis of the EHR use for each physician–nurse team in each practice, family medicine A, family medicine B, and specialty practice C were identified as having heterogeneous practice-level EHR use. Family medicine C, specialty practice A, and specialty practice B were identified as having homogeneous practice-level EHR use. Practices with fragmented communication patterns characterized by low to moderate levels of trust, diversity, heedful inter-relatedness, respectful interaction, social and task relatedness, and rich and lean communication displayed heterogeneous EHR use. Practices with cohesive communication patterns characterized by moderate to high levels of these same characteristics displayed homogeneous EHR use. Table 4 summarizes these findings.

Communication patterns and standardized EHR use

We identified key differences between practices where EHR use was standardized and practices that were furthest from achieving standardized EHR use. We categorized EHR use as standardized in practices where EHR use was uniformly high across all users. At the time of the study, specialty practices A and B had achieved standardized EHR use. Family practice A and specialty practice C were furthest from achieving standardized EHR use with one or more physician–nurse teams exhibiting low EHR use. Of the seven characteristics used to study within-practice communication patterns, mindfulness and respectful interaction were most relevant in distinguishing between practices that had achieved standardized EHR use and practices that were furthest from achieving standardized use. Table 5 summarizes these findings. We discuss the study findings and their implications for research and practice in the next section.

DISCUSSION

This study explores and describes an association between communication patterns and EHR use at the practice level of analysis in an ambulatory care setting. Because of its in-depth exploratory approach, the strength of this study is in generating new hypotheses for future research rather than testing a hypothesis. Thus, the findings from this study should be used to inform research aimed at discovering new understanding of how practice communication patterns and EHR use are related and to support practical efforts aimed at developing new strategies for implementing and managing EHRs.

Communication patterns are an important component of the human element within medical practices. Communication patterns can be fragmented or cohesive, and they can be useful in thinking about challenges associated with standardizing EHR use across diverse medical practices. The communication patterns in practices can be used to segment EHR users to better address the specific barriers different user groups may have with regard to this HIT. It is important to point out that not only can differences in within-practice communication patterns exist within the same medical organization, but that they can change over time. The latter point is particularly important in developing strategies for shaping and leveraging within-practice communication patterns for improved EHR use. When members of a group hold a consistent mental model about the core purpose(s) of the group, group performance tends to be better

than when they lack this consistent mental model.⁴⁹ Understanding the relationship between communication patterns and EHR use may provide key lessons for implementing EHRs in ways that promote higher and more effective and meaningful patterns of EHR use without unnecessarily restricting customizations needed to accommodate genuine differences between individual physicians and physician practices.

Understanding the communication patterns in a practice may be helpful in implementing EHRs and in influencing EHR use after implementation. For example, in practices where communication patterns are cohesive, perhaps working with one physician or nurse on EHR issues may be sufficient to improve EHR use throughout the practice. In practices where communication patterns are more fragmented, EHR support staff may need to work with each individual to achieve EHR use goals set by the larger organization. We noted that, in addition to being more homogeneous, practice-level EHR use tended to be higher in practices with cohesive communication patterns when compared with practices with fragmented communication patterns. Unpacking the label cohesive, we can further interpret this finding using the model of practice relationships³⁸ to mean that practices characterized by higher levels of trust, diversity, mindfulness, heedful inter-relation, respectful interaction, social and task relatedness, and rich and lean communication may be more likely to develop higher EHR use than practices with low levels of these characteristics.

When we examined more closely the within-practice communication patterns that most effectively distinguished practices that had achieved uniformly high levels of EHR use from practices that were furthest from achieving this pattern of EHR use, we found that mindfulness and respectful interaction were key distinguishing characteristics. Mindfulness is defined as openness to new ideas and seeking novelty even in routine situations.^{50–52} Respectful interaction is honest, self-confident, and appreciative interaction among individuals, often resulting in the creation of new meaning.⁵³ Our results suggest that incorporating a focus on promoting mindfulness and respectful interaction among practice members into EHR implementation strategies could be important to achieving high levels of EHR use in ambulatory care settings. These findings are consistent with an emerging literature that highlights the importance of work relationships,³⁸ reflection,⁴² and conversation⁵⁴ in the performance of healthcare delivery systems, and that may also be relevant to solving some of the current EHR implementation and use challenges, particularly those involving social factors.

CAS theory can inform the study of EHR use. CAS theory has been used to understand numerous healthcare^{26 28 38 55 56} and information technology phenomena,^{30–32} and it informed this study in two major ways. First, the fact that diversity is a key component of CASs prompted us to study the differences in EHR use across practices as opposed to the similarities. Studying differences in EHR use across seemingly similar users could prove to be particularly valuable in understanding social and cognitive factors contributing to the historically low acceptance rates of this HIT and the wide-ranging differences in how EHRs are perceived by physicians and other medical professionals. Second, CAS theory prompted us to study the linkage between communication patterns and EHR use. Studying the interdependencies between system components is important in understanding how CASs function and change over time. Examining the linkage between within-practice communication patterns and practice-level EHR use was helpful in providing new information about the human element of EHR use.

Table 3 Communication patterns in practices

Practice	Characteristics	Communication patterns
Family medicine A	Low trust High diversity Low mindfulness Moderate heedful inter-relation Low respectful interaction Moderate social and task relatedness Moderate rich and lean communication	Fragmented
Exemplar quote	<i>'Because my partner and I are completely opposite in the way that we approach the EHR, and I have a paper chart, I usually make fun of him when our EHR is down, he's actually frozen in his tracks, he has no idea who somebody is, what medication they're on and he has no information because he has no paper backup; I'm still working because I work with paper and I'm not looking at somebody and saying, "Okay, who are you and what medications are you taking?" I don't look like an idiot you know.'</i>	
Family medicine B	Moderate trust Low diversity Moderate mindfulness Moderate heedful inter-relation Moderate respectful interaction Low social and task relatedness Moderate rich and lean communication	Fragmented
Exemplar quote	<i>'I used to see the other two doctors here as mentors but that's kind of changed now. We're always doing our own thing here...seeing our own patients you know and we don't really talk much about our work.'</i>	
Family medicine C	High trust Moderate diversity High mindfulness High heedful inter-relation High respectful interaction High social and task relatedness High rich and lean communication	Cohesive
Exemplar quote	<i>'We do things very differently from (family medicine B). We're more of a team on this side than they are over there. We work together to get the job done. If someone is out, we pick up the slack and get patients taken care of. Physicians don't have a nurse assigned to them on this side; any nurse can work with any physician. It's important that we work together to take care of our patients.'</i>	
Specialty practice A	High trust Moderate diversity High mindfulness High heedful inter-relation High respectful interaction Moderate social and task relatedness Moderate rich and lean communication	Cohesive
Exemplar quote	<i>'One of the things that might be an advantage for us is that it's just two of us and I think that we have a great relationship—we respect each other a lot and we are always talking about how to improve things not just for the electronic medical record but for the clinic as a whole and so we are constantly communicating, "Now what do you think of changing this? What do you think about tweaking that?" and we do that all day long, and so we have a really good, you know, relationship and supporting each other in improving our product together. We think alike and we both want this to work so that I think that gives us an advantage.'</i>	
Specialty practice B	High trust Moderate diversity High mindfulness High heedful inter-relation High respectful interaction Moderate social and task relatedness High rich and lean communication	Cohesive
Exemplar quote	<i>'I think everybody has an area of interest and expertise and; well I suppose again it's a team. So if this was a football team and I wasn't a good kicker but I could throw I'd naturally be the quarterback. So all of us partners would say we share, you know, we second opinion each other all the time, on cases. Or if there's an area that you know one guy clearly has an interest in, then, you know, we go to him. Not because he's smarter than the rest of us, it's just that he has an area of interest that's different than my own, so naturally he's more versed in that area.'</i>	
Specialty practice C	Moderate trust Moderate diversity Low mindfulness Moderate heedful inter-relation Low respectful interaction Low social and task relatedness Low rich and lean communication	Fragmented
Exemplar quote	<i>'I don't know why (Dr X) doesn't like the EHR. I think we have such differences because we think differently about how we practice medicine. I think that the more we can use this system, the more we'll know about our patients down the road. I don't think (Dr X) or (Dr Y) think this way. We all kind a do our own thing here.'</i>	

Table 4 Linking within-practice communication patterns and electronic health record (EHR) use patterns

Practice	Within-practice communication patterns	Physician—nurse team EHR use	Practice-level EHR use patterns
Family medicine A	Fragmented	Team 1—High Team 2—Low Team 3—Medium	Heterogeneous
Family medicine B	Fragmented	Team 1—High Team 2—Medium Team 3—Medium	Heterogeneous
Family medicine C	Cohesive	Team 1—Medium Team 2—Medium Team 3—Medium	Homogeneous
Specialty practice A	Cohesive	Team 1—High Team 2—High	Homogeneous
Specialty practice B	Cohesive	Team 1—High Team 2—High Team 3—High	Homogeneous
Specialty practice C	Fragmented	Team 1—Low Team 2—Medium Team 3—High Team 4—Low Team 5—High Team 6—Medium	Heterogeneous

Future research

The findings from this research suggest that communication patterns may be linked to EHR use in some previously unrecognized ways. Because our study was focused on establishing an

association between communication patterns and EHR use, we did not address the issue of causality. Thus, we cannot make claims as to whether heterogeneous EHR use led to fragmented communication patterns in practices or whether the presence of fragmented communication patterns in practices led to heterogeneous EHR use. Both sides of this question could be argued using existing theory. Additional research, however, is needed to determine the causal relationships as well as directionality between these variables.

Additional research is also needed to examine if and how medical specialty mediates the relationship between communication patterns and EHR use. Our findings suggest that medical specialty may play an important role in how practices both communicate with each other and use EHR systems. Between-medical specialty differences in EHR use was not the focus of this research and thus should not be used to make claims in this area. However, the findings from this study point to the possibility that EHR use by generalists and specialists in ambulatory care settings may be different from each other in some important ways. For instance, using the findings from this study, one could argue that physician practices that provide more general care (eg, primary care practices, family practices, and pediatric practices) see a wide range of diverse medical cases and thus may inherently have more fragmented within-practice communication patterns, which in turn may make it more likely that generalist practices will display more heterogeneity in how they

Table 5 Communication patterns and standardized electronic health record (EHR) use

Practice	Characteristics	Physician—nurse team EHR use	Practice EHR use
Family medicine A	Low trust High diversity Low mindfulness Moderate heedful inter-relation Low respectful interaction Moderate social and task relatedness Moderate rich and lean communication	Team 1—High Team 2—Low Team 3—Medium	Heterogeneous
Family medicine B	Moderate trust Low diversity Moderate mindfulness Moderate heedful inter-relation Moderate respectful interaction Low social and task relatedness Moderate rich and lean communication	Team 1—High Team 2—Medium Team 3—Medium	Heterogeneous
Family medicine C	High trust Moderate diversity High mindfulness High heedful inter-relation High respectful interaction High social and task relatedness High rich and lean communication	Team 1—Medium Team 2—Medium Team 3—Medium	Homogeneous
Specialty practice A	High trust Moderate diversity High mindfulness High heedful inter-relation High respectful interaction Moderate social and task relatedness Moderate rich and lean communication	Team 1—High Team 2—High	Homogeneous and standardized
Specialty practice B	High trust Moderate diversity High mindfulness High heedful inter-relation High respectful interaction Moderate social and task relatedness High rich and lean communication	Team 1—High Team 2—High Team 3—High Team 4—High	Homogeneous and standardized
Specialty practice C	Moderate trust Moderate diversity Low mindfulness Moderate heedful inter-relation Low respectful interaction Low social and task relatedness Low rich and lean communication	Team 1—Low Team 2—Medium Team 3—High Team 4—Low Team 5—High Team 6—Medium	Heterogeneous

use the EHR system as a group. Using the same logic, one could argue that physician practices that provide more specialized care (eg, podiatry, cardiology, and dermatology) see a more narrowly focused set of medical cases and thus may inherently have more cohesive within-practice communication patterns, which in turn may make it more likely that specialist practices will display more homogeneity in how they use the EHR system as a group. Future research might also consider examining the relationship between communication patterns and EHR use patterns in ambulatory practices using different commercial products to evaluate the kinds of EHR products that work better for generalist practices and those that work better for specialty practices.

While mindfulness and respectful interaction were found to be important in distinguishing between practices that had achieved standardized EHR use and practices that were furthest from achieving standardized use, additional research is needed to more systematically examine these associations. Insights into how these variables are associated with practice-level EHR use could be key to the development of new strategies for implementing and managing EHRs in a variety of healthcare delivery settings. Additionally, future studies on this topic might consider including the patient as a participant in within-practice communication patterns to examine the patient's role in this relationship.

Limitations

Despite its contributions and strengths, this study is limited in several ways. First, because of the exploratory and in-depth qualitative approach, the study was conducted over a small number of sites within one multi-specialty ambulatory care organization. For this reason, the results are less amenable to replication because of the time required to conduct interviews, observe work processes, and construct variables. Similarly, while the findings from this study might be transferable to other similar contexts, they should not be considered generalizable. A second limitation is that this study focused on examining within-practice communication patterns from a perspective that assumed practice members were more or less equal in their capacity to influence the practice regardless of their rank, role, or title. While there are benefits to this approach, this study pays less attention to characteristics such as power and leadership structures, which have also been shown to be important.⁵⁷ Finally, because this is a cross-sectional as opposed to a longitudinal study, claims about directionality and/or causality cannot be made with this dataset.

CONCLUSION

National health policy initiatives emphasize EHRs as a way to address many of the challenges facing healthcare delivery systems today. Solid progress is being made in terms of EHR acceptance and adoption rates¹⁷; however, significant challenges remain—particularly in terms of our understanding of how the human element influences EHR acceptance, implementation, and use. Studying the linkage between communication patterns and EHR use patterns is an important step toward new understanding of the social intricacies involved in introducing HIT into healthcare delivery systems.

In this study, we found that practices with fragmented communication patterns displayed heterogeneous EHR use, and practices with cohesive communication patterns displayed homogeneous EHR use. Additional analysis revealed that practices that had achieved standardized EHR use (uniformly high EHR use across all users) exhibited high levels of mindfulness and

respectful interaction among practice members, whereas practices that were furthest from achieving standardized EHR use exhibited low levels of mindfulness and respectful interaction.

Understanding the communication patterns among practice members may provide a path toward achieving more standardized EHR use in ambulatory care settings. Moreover, understanding the linkage between communication patterns and EHR use patterns can generate knowledge about the human element in EHR use and may provide key lessons for the implementation of EHRs and other HITs. Although alignment of financial incentives and provision of technical assistance for EHR implementation are important, this study suggests that patterns of within-practice communication could be an additional lever for positively shaping EHR implementation, acceptance, and use in healthcare delivery systems.

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