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Abstract

EHRs (Electronic Health Records), can contribute greatly to improving care and managing the rising costs of healthcare. The use and the integration of EHRs (Electronic Health Records) in supporting collaboration to increase the efficiency and effectiveness of healthcare remains a challenge. It appears that the physicians are at the center of this bottleneck.

As healthcare is provided by interdisciplinary teams of clinicians and collaboration and coordination are key to success. Literature suggests reasons for the limited use relate to policy, financial and usability considerations, but it does not provide an understanding of reasons for physicians' limited interaction and adaptation of EHR. This paper investigates how "meaningful use" of EHRs by physicians enable patient centered healthcare to be achieved.

Following an analysis of qualitative data, collected in a case study at a hospital using interviews, this research shows how a collaborative technology architecture can enable the reduction in the costs of healthcare and improvements in the quality of care by enabling more patient centered health care.

1. Introduction

The American Recovery and Reinvestment Act, passed in February 2009, included a very large stimulus payment for eligible providers, hospitals and physicians for the adoption of EHRs. If providers do not become meaningful users of EHRs by 2015, penalties will be triggered through reduced Medicare payments. The transformation of health care through the use of Health Information Technology continued with the passing of the Patient Protection and Affordable Care Act of 2010, which mandated the integration of physician quality reporting and Electronic Health Record reporting. This Act required the creation of measures and reporting of the "meaningful use of the electronic health record" and "quality of care furnished to an individual." In doing so, the law directly links the adoption of the electronic health record with quality of care to the patient. This entails coordination which the Act requires the use of "electronic health records and tele-health technology to better coordinate, manage and improve access to care.

This illustrates increasing pressure to operate efficiently in healthcare. Costs are spiraling out of control, due in part to huge amounts of redundancy and waste [17,18,28]. Research has shown that the healthcare industry is plagued by rapidly increasing costs, poor quality of service, lack of integration of patient care, and lack of information accessible via EHR [14,19,32]. Medical errors arise because of process failures, ineffective communication and lack of information. Blumenthal and Tavenner (2010) suggest that once patients experience the benefits of this technology, they will demand nothing less from their providers (p.501). The road to patient-centered care was paved with the passing of the Health Information Technology for Economic and Clinical Health Act (HITECH), which authorized incentive payments through Medicare and Medicaid to clinicians and hospitals when they use EHRs privately and securely to achieve specified improvements in care delivery..

Patient-Centered care is seen to be a natural progression towards greater efficiency and effectiveness in healthcare provision. This form of care is one in which the patient actively participates in his or her care, delivery of care takes place from a patient's point of view, there is greater communication with the patient and therapy is tailored to the needs of the patient [27,26, 39]. The implementation of Health Information Technology (HIT) appears to have enabled greater patient centered care through better access to patient data, shorter recovery through targeted care, lower cost through fewer tests and increased meaningful use practices [26,12,10,9].

Patient centered care relies on physicians' capturing the benefit from EHRs to collaborate with other medical practitioners ensuring that hospital care is improved. In practice, this is a challenge when physicians resist technology, rely on other medical personnel to communicate with the patient, and are accustomed to offering standardized therapies instead of those targeted to the partient's needs. The literature indicates that physicians resist the technology due to productivity issues, workflow challenges, lack of support and other issues [2,3,15,17,19,28]. This leads to high costs and reduction in quality. According to Clifton (2012), healthcare in America costs 2.5 trillion a year and is expected to grow to 4.5 trillion in six years. The Institute of Medicine (IOM, 2001) reported that the US healthcare system is "fundamentally broken" and called on the Federal Government to make a major investment in information technology in order to

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achieve the changes, such as the "commitment to technology to manage the knowledge bases and process of care" [18, p. 178] in order to repair the broken healthcare system. According to the Agency for Healthcare Quality and Research, automation is able to improve the quality and safety of care delivered by healthcare facilities by enabling collaboration amoung physicians, medical personnel and patients.

Understanding the healthcare context is key to understanding the integration of IS (Information Systems) into the fabric of their organizations. According to Fichman et al, at the most general level, 'a striking feature of healthcare industry is the level of diversity that characterizes patients (e.g. physical traits, and medical history), professional disciplines (e.g. doctors, nurses, administrators and insurers), treatment options, healthcare delivery processes and interests of various stakeholder groups [p. 419).

Patient centered care implies a paradigm shift in the relationship between doctors and patients, but also requires the development of patient-oriented research [39]. This paper answers the call for the development of patient-oriented research by investigating the key challenge relating to the "meaningful use" of the electronic health records for patient-centered care which is the exchange of data, their analysis, and sharing diagnosis and treatment information from the physicians to the people who need it. Given the multi-disciplinary nature of the healthcare providers, it appears that the physician is at the center of care provision and also the bottleneck according to Clifton [11]. It appears then that if EHR can serve as a means of enabling collaboration between and among health care providers and patients, then the transformations in IT enabled healthcare can be achieved.

The question investigated in this paper is*: how can "meaningful use" of EHRs by physicians enable patient centered healthcare?* Through a qualitative study that examines how physicians interact with technology, this research follows a qualitative grounded theory approach to arrive at the key concepts affecting clinical collaboration using EHRs. The key contribution of this research is in discovering the ways in which physicians' adaptation to EHRs may enable collaboration amongst clinicians to achieve improved patient centered care. Our analysis of how physicians achieve "meaningful use" of EHRs draws upon the Qureshi Keen model [35] to understand physician's interactions with EHR systems. Our analysis also draws upon Paul et al's (2013) ontology illustrating the potential of EHRs to provide continuity of service and support collaboration as physicians increasingly work with each other as well as other service providers.

2. Theoretical Background

Meaningful uses of EHRs by physicians have the potential to provide continuity of service and better care. If EHRs can be used by physicians to collaborate with each other and other service providers, than their use of EHRs can be seen to be meaningful, provided their collaboration leads to improved patient care. Previous technology research [42,43,44,45] has investigated collaboration effects and provides insight to inform the physician/EHR research in the areas of collaboration, coordination, communication and adaptation. In addition, the adaptation insights at the work, social, and technology levels inform this research.

Effective patient-centered care is about the identification of the best intervention for every individual patient using personalized medicine and tailored therapeutics [39]. However, current medical work practices revolve around the provider, in particular, the physicians' needs. According to Qureshi and Vogel's model of eCollaboration Effects, when people use technology to work with each other, they go through technological, work, and social processes in order to adapt to new work environments [37]. In order to provide meaningful patient centered care, physicians will have to collaborate. Collaboration is a purposeful joint action through the construction of relevant meanings that are shared among members. Collaboration is needed to: 1) determine what action is required and relevant; 2) identify knowledge to carry out a required action; 3) demand for action. In order to support collaboration, it is necessary to have a media with which to communicate and a social network or "community of minds."

Patient centered care improves with the meaningful adaptation of technology. The adaptation of new technology in collaborative relationships occurs when members of a group learn how new technology affects their work, relationships, and professional environment [34,36,37]. Successful collaboration requires social adaptation by team members, who must learn to conform to new knowledge, rules, and patterns of interaction.

Physicians using technology go through technological, work and social processes to adapt to new work environments. IT affects work relationships and environments. This paper briefly describes how IT affects work relationships and environments. A detailed analysis is given in another paper [29,36].IT affects the work process itself and the way in which work is carried out [34,37]. Technology adaptation occurs when people learn how to use technological tools to achieve their goals. The more flexible the technology, the easier it is for people to use the technology to meet their needs. In the context of the ontological framework provided by Paul et al (2013), this model contributes to an understanding of how the technology architecture can enable physicians to apply electronic health records, which is technological adaptation,

to work (work adaptation) together with their partners (social adaptation) using the content available to them and using the collaboration media to provide better healthcare.

In order to achieve meaningful use in patient centered care, the patient needs to take control of the management of their care. This is possible through information made available from EHR through HIT products such as home health devices and patient portals that enable better disease management through tracking of comprehensive health indicators and lower the cost of care [12,10]. A key challenge relating to the content of the electronic health records is the exchange of data, their analysis, and sharing diagnosis and treatment information from the physicians to the people who need it. According to Qureshi & Keen (2005), occupational communities can have difficulty sharing information between different domains of knowledge that is dispersed across different individuals. The healthcare implementation of EHRs has similar issues. Information technology solutions, such as the EHRs, tend to focus on stimulating knowledge collection by codifying or explicating knowledge. Typically, infrastructures are used for storing, managing and distributing explicit knowledge.

The theoretical framework of knowledge activation [35], suggests that knowledge use is shaped by three individual knowledge identities: 1) accountable which is part of individuals' professional lives; 2) discretionary which is theirs to share voluntarily; 3) autonomous which forms from their private experience. These identities determine the willingness of people to communicate and share. There are many incentives to share accountable knowledge, which is part of responsibility and position. There is less incentive to share discretionary and autonomous knowledge, which are personal and in many instances can be tacit information the owner is unaware of possessing or the owner may carefully guard as a component of his/her identity. The three types of knowledge can be activated through collaboration.

Challenges to technological adaptation lie in that the physician perspective is often overlooked. This is reflected in a seminal Simon quote, "This is an old weakness in engineering design, not peculiar to computers: we are fascinated with our technical capabilities and design sophisticated hammers which go around looking for nails that are shaped so as to be hammerable by them (p. 135)."

Difficulties of work adaptation can be seen in the reviews of (EHR) literature that show the existing challenges with the alignment of organizational design and the engineered artifact. Niazkhani et al [28, p. 546] concluded "When put in practice, the formal, predefined, stepwise, and role-based models of workflow underlying CPOE systems may show a fragile compatibility with the contingent, pragmatic, and co-constructive nature of workflow." Two of the findings of Greenhalgh et al. [17, p. 767] were "while secondary work (audit, research, billing) may be made more efficient by the EPR, primary clinical work is often made less efficient" and "the EPR may support, but will not drive, changes in the social order of the workplace."

The need for work adaptation to enable collaboration can be seen in Fontaine et al.'s [15] review of primary care that "The potential for HIE to reduce costs and improve the quality of health care in ambulatory primary care practices is well recognized but needs further empiric substantiation." IOM (2001) claimed that the healthcare system needs to join the IT revolution, and improved information systems may be a critical factor for advancing the healthcare system because of the pervasive need to access, record, and share information in order to provide high-quality medical care [18].

Knowledge and learning play important roles in the use of IT, and researchers have developed the diffusion, adoption, and acceptance theories to explain how people adopt, accept, and use complex organizational technologies. Attewell [4] defined complex organizational technologies as "technologies that, when first introduced, impose a substantial burden on would-be users in terms of the knowledge needed to use these technologies effectively [4]."

Successful adaptation can bring about benefits to the organization. From an organizational learning perspective, Attewell defined technology assimilation as "a process of organizational learning in which individuals and an organization as a whole acquire the knowledge and skills necessary to effectively apply the technology" [4, p. 13]. The burden of learning creates a knowledge barrier that inhibits the diffusion of IT. In these cases, the use of IT can be inhibited as much by the ability to adopt IT systems as the desire to adopt these systems. Both these challenges can be overcome through processes of adaption that enable collaborative practices to be brought to bear in activating knowledge. The following section describes the methodology used to investigate how adaptation of Electronic Health Records by physicians enables collaboration and better healthcare provision.

3. Research Methodology

This study uses a qualitative research method to examine physician interaction with EHRs. It uses Yin's case study approach, interviews as the primary data collection and open coding for data analysis. The Yin approach was chosen as it: 1) generates relationships or theory with constant comparison literature; 2) emergent theory is likely to be testable with constructs that can be readily measured; 3) high likelihood of valid relationships,

models or theory because the theory building process is tied to data and other evidence.

The hospital selected for this study is an early adopter of Electronic Health Records (EHR), which has achieved the *Meaningful Use* Stage 1 certification by the end of 2010. It has successfully integrated all of its internal units with various modules of a single EHR vendor. The data were collected over a three-month period from November 2011 to February 2012 at an acute care county hospital located in the Midwestern United States. This hospital was chosen because of its central location and importance in providing healthcare for the county. Twenty-eight physicians were chosen because of their position as resident physicians. The entire resident physician population was interviewed. The 28 interviews represented 38 pages of electronic transcripts.

Data was collected through questionnaire which comprised of four open-ended questions asking respondents about their perceptions and adoption experiences with the electronic health record technology. Fifteen female and thirteen male resident physicians completed and returned the questionnaire. There were eight first-year, eight second-year, eight third-year, and four transitional-year residents. Ages of the residents fell into two broad groups of those over twenty but under thirty and those over thirty but still under forty years old. Twenty residents were in the younger category and the remaining eight represented the adjacent older group. Participation was voluntary, electronic, and solicited via email. There was no direct financial reward for participation. However, the participating resident physicians had a chance to win a dinner-for-two voucher to a local restaurant.

Open coding is used to analyze the data and develop concepts as they relate to physician interaction with EHRs. The qualitative method and open coding analysis enables discovery of the relationships in the real world situation. Theoretical sensitivity allows the researcher to have insight into and to give meaning to the events and happenings in data. "Insights do not just occur haphazardly; rather, they happen to prepared minds during interplay with the data [49, p. 47]." Eisenhardt's enfolding the literature step complements the development of sensitivity. "An essential feature of theory building is the comparison of the emergent concepts, theory, or hypotheses with the extant literature [13, p. 544]." This research utilizes theoretical sensitivity and enfolding the literature to develop the lens for the effort and to strengthen the results. That is, it is discovered, developed, and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon [43,p.23]. This approach is consistent with generally accepted approaches to develop relationships or theory from cases [5,13,44,49].

4. Results & Analysis

While analyzing the transcripts of the interviews, "labels of meaning" were identified and placed next to the relevant occurrence. Occurrences were events, happenings, actions, feelings, perspectives, actions and interactions. Categorization of the coding was done in two phases. First, the data obtained from the interviews were coded into broad categories. The interview data were analyzed using Strauss & Corbin's [43] open coding method. Open coding was used to conceptualize raw data by naming and categorizing the encountered phenomena through close examination of the data. During open coding, data were broken down into discrete parts, closely examined, and compared for similarities and differences.

The coding process yielded 206 coded quotes. The data representing events, happenings, actions and interactions that were found to be conceptually similar in nature or related in meaning were grouped under abstract concepts that best represent the phenomenon. According to Strauss and Corbin [43], although events or happenings might be discrete elements, the fact that they share common characteristics or related meanings enables them to be grouped. Based on their ability to explain what is going on, certain concepts were grouped under more abstract higher order concepts which Strauss and Corbin [43] term category. Categories have analytic power because they can have the potential to explain why physicians may or may not use the technology and potentially predict the effects of certain implementations on physicians' use. The 206 labels were categorized to compare codes across the interviews. The categories were derived by tabulating the number of occurrences of related concepts.

Reliability of these groupings was achieved through theoretical sensitivity, iterative coding, and theoretical sampling. Strauss and Corbin [43] suggest that theoretical sensitivity is required to enable the researcher to interpret and define data and thus develop relationships, models or theories that are grounded, conceptually dense, and well integrated. Sources of theoretical sensitivity are the literature, professional, and personal experiences. Additional reliability was achieved through the iterative use of open and axial coding to bring out the concepts and discover any causal relationships or patterns in the data.

Further reliability was achieved through theoretical sampling, which is the sampling of data on the basis of concepts that have proven theoretical relevance to evolving relationships, models or theories. The form of open sampling used was open sampling which is associated with open coding. Open sampling was used to select additional interview data. The 'slices of data' of all kinds, as Urquhart [47] describes this process, are selected by a process of theoretical sampling, where the researcher decides on analytical grounds where to sample from next.

In this, the researcher does not approach reality as a tabula rasa but must have a perspective that will help him or her abstract significant categories from the data based on the constructs identified in the literature [42,43]. This data analysis produced technological, work, and social adaptation categories. A further analysis of adaptation at each of the three levels revealed the level the physicians are able to use EHRs to support their work practices, level of technological comfort, and social interactions/connections. The categories, descriptions and number of occurrences are shown in Table 1: Physicians' Adaptation of EHR.

Table 1: Physicians' Adaptation of EHR

Category	Description	Occurrences
Work	The physician perspective of EHR usage on physician work. Subcategories: Work Impact, Productivity, Integrated Collaboration, Access/Connectivity, Requested Enhancements, EHR Here to Stay.	102
Technological	The physician perspective on implications of IT Context on EHR usage. Sub-categories: Systems Development, Hardware & Configuration, Physician Communication & Collaboration.	70
Social	The physician perspective on implications of social context on EHR usage. Sub-categories: Standard Templates, Processes & Rules, Data, Interfaces & Presentation, Knowledge & Learning.	34
Total		206

The results of open coding in table 1 illustrate that the greater portion of meaningful use by physicians was for work adaption. Of the "meaningful use" objectives identified by Blumenthal and Tavenner (2010), the majority of work adaptations by the physicians in this study involved "recording, ordering and sharing of medications", "medication instructions, dosage", and "admission orders". There was little in terms of the more collaborative aspects of the technology relating to diagnosis, clinical information and sharing of information among providers and patient-authorized entities. There was no information provided to patients nor was there any feedback from the patients as to drug interactions. These results suggest that the physicians' adaptation of the EHRs meaningful use was limited.

4.1 Physicians' Work Adaptation of EHR

Delving further into the work adaptation of EHR by the physicians, this section reveals the categories and the extent to which these were considered positive or negative by the physicians in this study. The results of the coding analysis revealed that 49.5 percent of occurrences related (106/206) to work adaptation, and sixty-three percent of reported work adaptations were positive. This is an interesting finding as previous research indicated low levels work adaptation by physicians. The previous findings of Qureshi & Noteboom indicated 'digital natives' often requested enhancements and integration of technology in the adaptation process. The analysis of resident data also supports this claim. The residents had 14 requests for enhancements to improve the integration of work.
These results are depicted in Table 2 below:

Table 2: Physicians' Work Adaptation

Work Adaptation	Description	Pos (+)	Neg (-)	Total
Impact on Work Practices	Physician perspective of influence of EHR on physician work.	12	19	31
Impact on Physician Productivity	The physician perspective of impact of EHR on physician productivity.	3	17	20
Connectedness	The physician perspective on connectivity, technology supported connectedness and remote access capabilities of EHR.	11	0	11
Integrated Collaboration	The physician perspective on integrated systems, data collaboration	20	3	23
Requested Enhancements	The physician perspective of requested enhancements to support their work efforts.	14	0	14
EHR Permanence	The physician perspective on realization EHR is becoming a permanent part of their work landscape.	7	0	7
Totals		67	39	106

These results illustrate that there was some degree of connectedness (11 positive occurrences) and integrated collaboration (20 positive and 3 negative occurrences). However, there was a sense from the physicians that there

was a net negative effect of the technology on their work practices and productivity. Physicians have experienced highly demanding educational and specialized training and are considered field experts. Findings from prior research suggest that physicians are reluctant to give a positive response to an implementation of an IS (information system) that interferes with their existing routines [32]. A key element in understanding physician use of EHRs is the critical role played by expertise and values in their work processes. Anderson & McDaniel feel that professional expertise and values can be powerful inhibitors of innovation. As the following quotes illustrate, the residents were able to identify positive as well as negative aspects of working within the EHR system:

"I appreciate the standardization and ease of getting access to a patient's records from anywhere. Overall, I wouldn't trade an EMR for ANY paper charting."

"The system has a tendency to force me into selecting a specific order set, due to lack of flexibility."

This research highlights that the physicians' response to the lack of support for their knowledge needs and routines is to request additional system enhancements for their work and data access. At the same time the data and above results illustrate the transformation in health care witnessed through the responses from the physicians.

4.2 Physicians' Technological Adaptation of EHR

Technological adaptation amongst physicians appears to be influenced by their level of comfort and experience with technology. While older physicians are opinion leaders with respect to clinical decisions, younger physicians are frequently leaders in using information technology [1]. The following table 3, illustrates the results of technology adaptation from the open coding:

Table 3: Physicians' Technology Adaption

Technology Adaptation	Description	Pos (+)	Neg (-)	Total
Systems Development	The physician perspective on the development aspects of the EHR and functionality.	**7**	**3**	**9**
Hardware & Configuration	The physician perspective on the hardware, performance and configuration aspects of the EHR.	0	17	17
Physician Communication & Collaboration	The physician perspective on collaboration & communication functionality.	0	9	9
Totals		7	29	36

The technical adaptation subcategories were primarily infrastructure and support issues. They primarily deal with the physician perspective of how the system was developed and implemented, training, support and functionalities of the system. Its context issues have the potential power to influence IT adaptation (6, p. 505).

The data indicate the system development area does not appear to be physician driven. They have many requests for improved search and data access improvements. In addition, there is a concern with the hardware and configuration area. The physicians indicate concerns with downtime and slow response time. These concerns lessen the availability of the EHR and the access of the system affects patient care as well as productivity. The availability and performance concerns were all negative. The data indicate physicians want to utilize various hardware devices, such as tablet PCs, and they voice dissatisfaction with the present interface. Hence, the frustration amongst physicians and their loss of productivity because of EHR persists. The data indicate that physicians encounter difficulty communicating and collaborating with RNs (registered nurses) and specialty areas. The lack of concurrent access appears to be the biggest area of concern and results in productivity loss, communication inefficiency and collaboration interference. The following quotes are examples:

"I feel I have lost many hours of productivity or sleep during my residency waiting for the system to change from screen to screen."

"Now add this poor functionality that barely works in Windows to the iPad trying to run Windows and right-click select becomes double tap and select. The inconsistency of the systems products creates a great amount of specific learning required."

"upgrades are downgrades"

"..it shouldn't require 30 mouse clicks to put in an order to start an IV, I suspect there is an assumption that the click of a mouse equals simplicity but when you have to wait 5 mins for computer to load or get lost in some screens it can take much longer to achieve what you wish."

We need better communication with nursing. All orders need to be seen by nursing and providers and nurses should not have to fight over who has control of the chart, this slows things down if one has to wait for the other to get out.

As illustrated by the above quotes, EHR appears to be a new technology that is often considered additional work resulting in reduced productivity by the physicians required to use it. At the same time, the benefits of using EHRs have been touted by administrators and politicians. If the physician has a need to address a problem, the physician will turn to technology or other care providers. The physicians in this research all identified a need for additional representations and analysis tools to interface with the clinical data. In fact, they have expressed dissatisfaction with the lack of delivery of such types of tools. An EHR solution must contain more than 'automating' functionality, it must enable 'informating' functionality and support collaboration amongst healthcare professionals.

4.3 Physicians' Social Adaptation

Successful collaboration requires social adaptation by team members who must learn to conform to new knowledge, rules and patterns of interaction. Some of the rules and processes may not be perceived as supportive by physicians. Clinical collaboration rules tend to require adherence to practice processes and rules. It focuses physician attention on the details of data entry and interferes with their thought process and ability to contemplate the 'big picture'. The following table 4 illustrates the results of the open coding relating to social adaptation for clinical collaboration.

Table 4: Physicians Social Adaptation for Clinical Collaboration

Social Adaptation	Description	Pos (+)	Neg (-)	Total
Standard Templates, Processes & Rules	The physician perspective on the standard templates, processes and rules within the EHR.	**17**	**28**	**45**
Data, Interfaces & Presentation	The physician perspective on the presentation of data and ability to support thought.	0	10	10
Knowledge and Learning	The physician perspective on training, learning and knowledge transfer.	0	6	6
Totals		17	44	61

The above results from the open coding suggest that the physicians' adaptations for clinical collaboration were largely negative. It appears that in order for adaptation to take place for clinical collaboration, the knowledge identities of the physicians need to be addressed. In particular, the physicians' ability to care for patients not only depends on their explicit knowledge, professional identity and accountable knowledge, but their intuition and experience. It is their ability to utilize 'sensemaking' [40] that must be emphasized and supported to enable physician work processes. The adaptation of the technology appears to be a barrier to activation of clinical skills and is supported by this research as indicated by the following quotes from physicians:

"…seems everytime I learn to do something one way IT makes an update and I have to relearn (usually by a mistake) how to do the same thing again…"

"…this is the least intuitive interface I've used and the fact that everyone has a different interface (pharmacy vs PT vs nurses, etc) means we can't help each other learn as well…"

"…unable to move easily between screens (can't open notes and labs at the same time, for example). progress notes are poorly designed (hard to write an assessment/plan, lots of redundancy in data presentation) …"

"…it slows me down, doesn't improve patient safety (in fact, worsens it at times), doesn't make me feel confident that I'm providing the best care of which I (and the clinic) is capable."

"EMR is here to stay but this system isn't the best program available."

The above quotes illustrate that when the implementation of information systems interferes with physicians' traditional practice routines, the underlying technology is not likely to be intuitive and support the physicians [2]. According to Anderson (1997), physicians will oppose any systems that impose major limitation on how clinical data are recorded and how the medical record is organized. Physicians feel that it interferes with the way they organize their thought processes in caring for patients. Understanding how physicians work with knowledge in the healthcare domain and the knowledge identities they utilize is an important step in understanding the physicians' perspective on EHR usage.

5. Improving EHR Enhance Patient Care

This research has found that the data retrieval and analysis functionality serves as a technology mediator for the EHR. While the work adaptation of EHRs by physicians is largely positive and can lead to meaningful use, their technology and social adaptations remain largely negative. In particular, clinical collaboration and patient interactions remain minimal. While there may be functionalities to

support the collaboration and interactions, these have not been realized through the EHR functionality in the hospital studied. In the context of Paul et al's (2013) ontology, this means that the technology enables the use of content to the extent that physicians are able to use the media. It also appears that the technology was out of sync with the responsibilities and organizational processes surrounding the work practices of the physicians. The following table 5 illustrates the constraints surrounding Physicians adaptation of the technology and the opportunities available for patient centered health care.

Table 5: Physicians' Adaptation for Patient Centered Care

Organization	Constraints	Opportunities
Structure	The use of EHR may bring additional complexity into the work environment.	Support physicians with varying degrees of permanence. The frequency with which physicians interact with patients.
Specialization	Different specialties and physician responsibilities.	Integration of data sources from within the organization and integration with clinic and other environments.
Coordination	The flow of information does not appear to support the physician work. The requirement to enter fields in a disruptive order causes loss of thought flow.	The role of the physician and the structure of physician work supported by the EHR. Coordination of patient care.
Task	Information accessibility may vary. Ability to use the technology and to adapt to it may be difficult.	Process gains in terms of productivity, physician practice support and system enhancement.
Learning	The learning opportunities do not appeal to physicians. The ability to work without error is a requirement for EHR usage.	Greater flexibility in opportunities provided for learning and knowledge transfer. Support for patient information access and learning.

The table above uses the work of Qureshi & Vogel (2001), who found that successful adaptation of technology to work-environments should have the following components: structure, specialization, coordination, task and learning. The authors definition of these components are as follows: 1) the structure is organizational structure within which the EHR is used; 2) the specialization is the specialization of parts which are seen to require integrating mechanisms; 3) the coordination is the connection between different parts or components and content; 4) the task is the specific tasks or processes carried out through the use of specific knowledge and expertise; 5) the learning is as an adaptability to change and an ability to build up a collective reservoir of knowledge and skill.

The analysis depicted in the above table 5, shows how patient centered care is more likely using the EHRs, even if the technology may not support collaboration in the clinical process. It appears that the EHRs are the catalyst that enables physicians to learn about what the technology can do for them while experiencing the information and knowledge their patients are able to glean from the internet. The following section distills the analysis and offers insights into how physician collaboration may be supported for improved patient centered care.

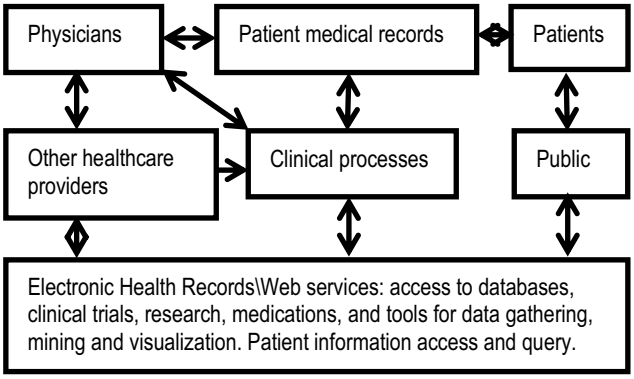
6. Collaboration for Patient Centered Care.

With the increasing impetus to measure the quality of care, the electronic health records are bringing the patient's perspective into the provision of health care. However, the results of this research have shown that, despite their functionality to support collaboration, the EHRs have not been able to support collaborative care for the most part. It has become more common for patients to search the web and come up with diagnosis and treatments that physicians may not agree with. Given the transformation of health care with Health Information Technology (HIT), Agarwal et al. [3] suggest that the future is not so much in aligning technologies to work practices but is in the use of web services with predefined interfaces and functionality which might not be compatible with existing practice. They foresee the existence of this type of incongruence between the HIT artifacts and work practices to continue as the existing work practices are ripe with inefficiencies. They also identify another prominent function that is lacking in most current systems is support for "rapid learning," where physicians are able to access and swiftly apply findings related to the efficacy of treatments and drugs from biomedical studies to the delivery of care. They also envisage greater use of off the shelf packages as opposed to in-house development.

EHRs supported by web services that enable Physicians to access information on the latest clinical trials, query databases to find out what would be the most appropriate treatments for their patients are the way forward. Patients also need access to information about their care providers, known treatments, medications and reactions to them. With improved use of information

physicians are able to provide care targeted to their patient's needs while patients are able to ask the right questions and know when to go for other medical opinions. These processes of clinical collaboration that are supported by web services are illustrated in Figure 2:

Figure 2: Model for Physician Collaboration for Patient Centered Care.



The model in figure 2 illustrates the collaboration process needed to provide patient centered care. This patient centered model of technology supported healthacre develops upon what we know about the challenges facing the adoption of EHRs and use the adaptation processes to arrive at ways in which the technologies can be used more effectively by both physicians and patients to improve quality of care. While it is accepted that the patient-physician relationship is at the center of healthcare-provision, access to needed information, techniques and tests is a vital part of this process. This model illustrates how integrating patient medical records with the clinical processes through EHRs with web services can enable physicians, healthcare providers and patients to access knowledge and information needed for "meaningful use" and improved care through personalized medicine and tailored therapeutics by enabling patients to use technology to manage their own care [10, 12,27,39] .

7. Summary & Conclusions

The rising cost and decreasing quality of health care has raised the impetus towards the use of EHRs to overcome these issues with the increased transparency and increases in efficiency made possible by the technology. However, the challenges to adoption of EHRs by physicians have tempered efforts to improve efficiency of healthcare through the technology. This paper has investigated: *how can "meaningful use" of EHRs by physicians enable patient centered healthcare?* The research has investigated how EHR adaptation by physicians can enable better healthcare provision by addressing their knowledge identities and need to keep them updated.

The results of this research have shown that EHRs have the potential to provide clinical collaboration and increased patient participation. The physicians' adaptation of the technology can enable better collaboration and support as they assess and verify the data, solve problems, and find innovative solutions to the conditions for which there are few treatments. In order to achieve better quality of care, the electronic health records with web services can provide the transparency needed as physicians utilize the technology to exchange content and patient interaction to enable patients to access the information they need to make better decisions about their healthcare. Further research will need to assess outcomes of patient centered care using technology products that use E.H.R data.

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