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The adoption of technology orientation in healthcare delivery

Case study of a large-scale hospital and healthcare system's electronic health record

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Abstract

Purpose – The purpose of this paper is to explore the role of technology through the study of electronic health record system in delivering patient-centered services. The goal is to identify the antecedents and consequences of adopting a technology orientation (TECHOR) approach in a large-scale hospital and healthcare system.

Design/methodology/approach – A grounded approach is used whereby extensive literature review and field studies were conducted over a two-year period. The three major field research activities included observation on hospital premises, semi-structured interviews, and focus group discussions with hospital employees from a large-scale hospital and healthcare system.

Findings – The findings reveal that TECHOR is institutionalized as a result of its demonstrated effectiveness in delivering patient-centered services with improved cost effectiveness, efficiency, safety, and quality control.

Research limitations/implications – Empirical testing of the presented framework is an important future research direction to validate the current qualitative investigation.

Practical implications – By understanding the driving forces and consequences of TECHOR, healthcare managers can better understand and manage their technology initiatives. Such effort will help healthcare organizations to create new services in meeting evolving demands and establishing long-lasting competitive advantage.

Originality/value – This paper fulfills a research gap by presenting a firm-level construct crucial to successful planning and implementation of technology-enabled health services.

Keywords United States of America, Hospitals, Medical information systems, Computer applications, Technology led strategy

Paper type Research paper

Introduction

Many healthcare organizations are convinced that to practice medicine in the digital era, they need clinical information and administrative tools that can be immediately accessible. Increasingly, healthcare providers are adopting various technologies to meet the complexities of today's healthcare demands, regulatory requirements, and ever rising consumers' expectations. Government and private organizations in the UK and the USA have also called for expanded use of hospital information technologies (HIT) beyond the

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incorporation of clinical decision support systems (Javitt *et al.*, 2005). For example, the use of electronic health record (EHR) systems, with electronic access to patients' medical records, physicians' notes, treatment alerts reminders, and more, is becoming a common practice in providing patient-centered health services. EHR is selected for this study because it has become one of the widely adopted tools in data management. The practice to actively employ technologies in day-to-day operation is referred to as a technology orientation (TECHOR) approach. It involves an organizational-wide effort and willingness to adopt and utilize technologies to improve organizational outcomes. In addition, this approach is generally motivated by sturdy forces and thus organizations are inclined to consider available technology options.

Although technology utilization in the healthcare industry has become a common practice and is well accepted by all stakeholders, the concept of TECHOR in relation to its driving forces and intended outcomes has not been explored. Extant literature on this topic focuses on product innovation (Salavou, 2003), breakthrough technologies (Zhou *et al.*, 2005), sales technology (Hunter and Perreault, 2006), and managers' attitudes toward information technology (IT) (Chahal and Kohli, 2006). Technology studies within the healthcare industry mainly focuses on hospital employees' management decision (Levaggi *et al.*, 2009; Li and Benton, 2006), organization's financial performance (Menachemi *et al.*, 2006), and consumer acceptance (Schur and Berk, 2008). Considering the increased exploration and exploitation of technological tools to advance medical knowledge and facilitate operational functions, the role of technology is in need of deeper exploration and understanding. A systematic investigation of TECHOR would allow organizations to better develop their technology initiatives and craft appropriate strategies to meet the growing demand of technological use.

This study aims to fill the above research gap by examining the adoption of TECHOR and how it facilitates operations and reveals new solutions to changing processes. Specifically, this paper uses a grounded theory approach to examine technological influences on healthcare practices, the antecedents or driving forces, and the resulting intended outcomes. A grounded theory perspective is appropriate for studying a new topic because it aims to build substantive theory with careful consideration of the focal phenomena. Such theory is grounded to the real world with specificity and practical utility (Goulding, 2005). A large-scale hospital and healthcare system (hereafter hospital system) in the State of Ohio, USA participated in this study. Li and Benton (2006) argue that large hospital systems tend to invest more in tools and equipment for providing technology-related services than smaller hospitals. *Ceteris paribus*, some hospitals are more effective in managing HIT resources, and thus, they are often able to innovate via technology to drive value and generate new business models (Herzlinger, 2006). EHR is selected for this study because more and more organizations are adopting it to manage patients' health information. Hence, healthcare professionals are familiar with its technological features and would be able to answer questions related to the adoption and usage of EHR.

Background information

Technologies build order in organizational lives and influence how people work, communicate, and use healthcare. The introduction of computer and internet technology has drastically changed the practice of medicine in the twenty-first century. These technologies not only transformed how medical and surgical procedures can be

conducted, but also created unimaginable avenues for managing healthcare operations. The internet, for instance, offers unparalleled opportunity for health information to be disseminated instantaneously. For the first time ever, authorized parties can access and exchange information interactively and simultaneously without geographical boundaries. As IT transforms medicine forever, it is crucial to understand the adoption of TECHOR in relation to effective utilization in meeting the changing health service expectations.

Technology orientation

Unlike other orientation research such as the study of market orientation and customer orientation, the research stream on TECHOR is scanty and not well conceived at the present time. In the healthcare industry, several studies have found that transforming the healthcare delivery system through the means of HIT adoption such as the EHR systems could save US physician offices about $142 billion and US hospitals $371 billion over the next 15 years (Hillestad *et al.*, 2005; Senate Finance Committee, 2009). Deloitte Center for Health Care Solutions pegs the savings at $530 billion over ten years, based on improved efficiency and coordination (Keckley and Underwood, 2009).

To date, no single study has been conducted to examine how TECHOR is institutionalized within the healthcare industry. In accordance with goal setting and organization action literatures (Child, 1997; Pfeffer and Sutton, 1999), we posit orientation as organizations' disposition for actions directed towards goal fulfillment (Lytle *et al.*, 1998; Noble *et al.*, 2002). When employees adopt and share the same orientation, they are in agreement with organizational goals. For the purpose of this case study, we describe the concept of TECHOR as "an organizational-wide engagement of technology-oriented practices in developing policies, practices and procedures, and sensing and responding to technology opportunities. These activities will lead to technology adoption and utilization." Our proposed concept is based on extant orientation literature in that organizational goal and commitment to engage in certain practices will influence employees' actions and behaviors. Thus, the adoption of technology practices reflects collective efforts to embrace-related activities in day-to-day operation.

The scope of technology covers a broad spectrum in a healthcare setting, including clinical diagnostic tools, clinical decision support, hospital information management, laboratory equipment, surgical robotics, and other biomedical engineering inventions. Examples of changes in technology-enabled services include new medical and surgical procedures (e.g. angioplasty, joint replacements), drugs (e.g. biologic agents), medical devices (e.g. computed tomography (CT) scanners, implantable defibrillators), and new support systems (e.g. electronic medical records, telemedicine). Technology is omnipresent and very little in the field of medicine has not been affected by new technology (Moseley, 2005). This paper investigates EHR's adoption and usage patterns in search for the driving forces and anticipated outcomes. The rational for selecting EHR is due to its commonly shared features that are familiar to most healthcare providers. EHR has become a common tool used among healthcare professionals to access patients' information electronically.

Electronic health record

The concept of storing health information via online repositories is now commonly known as EHR. In its most simple form, EHR is defined as computerization of health

content and associated processes (Atreja *et al.*, 2008). The term EHR has been used interchangeably with electronic medical record but significant differences exist between the two terminologies. The electronic medical record refers to the electronic record created in an ambulatory clinic, hospital or healthcare institution, whereas the EHR is a longitudinal record that receives information from multiple sources. The latter is broader in scope and offers a plethora of advantages for its potential to improve the quality of patient care, reduce cost, and accommodate all types of administrative, transactional and educational needs (Mehta and Partin, 2007). Since both electronic medical record and EHR are considered e-health services, they can affect patients' satisfaction, perceived quality, and behavioral intentions (Hadwich *et al.*, 2010; Whetstone and Goldsmith, 2009). Most importantly, it creates opportunities to improve provider-patient communication via messaging, and quick access to electronic record and alternative treatment options (Mukherjee and McGinnis, 2007).

In the most recently reported survey in the USA, EHR systems are used by 12 percent of physicians and 11 percent of hospitals nationwide (Hagen, 2008). The early success stories are making it a first in a series of effective examples. However, critics concerns about technology readiness of the organization and about technology obsolescence. Smaller hospitals and private healthcare providers are still relatively nascent in using EHR to support patient care. Nonetheless, past research pointed out that in a smaller healthcare setting, it can be easier to adopt changes and obtain consensus with a smaller work force (Masspro.org, 2006). As part of the US National Academy of Sciences' effort to encourage the adoption of EHR, the Institute of Medicine actively advocates the migration from paper-based health records to an integrated system that aims to perform and promote greater efficiency, safety, and quality healthcare delivery (Institute of Medicine, 2003). According to the Institute of Medicine, a defined IT infrastructure would include Institute of Medicine recommended functions so that allergies, clinical narratives, demographics, laboratory test results, medical and nursing diagnoses, and medication lists are all available online for access by care providers.

Methodology

This study uses a grounded theory approach that emphasizes field research in the form of observation and qualitative interviews. Such approach captures rich descriptions and narratives that yield theoretical insights through events and incidents (Corbin and Strauss, 1990; Eisenhardt, 1989) by understating the theory complexity in a new area. Inherent in this methodology is a commitment to discovery through direct contact with focal phenomena, rather than a priori theorization (Locke, 2000). The topic was selected based on a pilot study with industry experts, extensive literature review, and secondary research on the movement towards developing a comprehensive EHR.

Sample

The participating hospital system is a multispecialty medical center in the State of Ohio that serves its communities through more than a dozen hospitals plus affiliates. To protect its identity, the bed size of the participating hospitals is 504 when multiplied by a constant. A total of 128 hospital employees from this healthcare system participated in this research study. Two upper-level clinical directors and one hospital administrator agreed to be our key informants. As shown in Table I, the employees participating in the study were classified as top management ($n = 2$); middle management ($n = 26$),

Top management	
Executive officers and directors	2
Middle management	
Hospital administrators	4
Supervisors	10
Unit managers	12
Health care providers	
Physicians	15
Nurses	20
Occupational therapists	8
Patient care providers	
Frontliners	22
Pharmacists	6
Support stuff	16
Technicians	5
Other	
Consultant, contract workers, and interns	8

Table I. Participants' job categories

clinical care providers ($n = 43$), patient care providers ($n = 49$), and other employees ($n = 8$). About 63 percent of the participants were female and 92 percent were full-time employees. Over 80 percent of the participants were between the ages of 30 and 59. Additional demographic details are shown in Table II.

Field studies

The research team began by conducting an intensive literature review on the topic before initiating discussions with key informants about the research objectives and pedagogical values of the study. Two industry experts who were former hospital administrators provided guidance on narrowing the scope of the research by focusing on EHR systems instead of every adopted technology. The rationale is most hospital employees will be familiar with the EHR systems due to its widely adopted functions in healthcare services delivery process. Next, the research team sent research invitations to selected clinical and ancillary departments based on insights from key informants. Figure 1 shows a flow chart of the field studies conducted over a two-year time period.

	%
Gender	
Male	37
Female	63
Status	
Full-time	92
Part-time	8
Age group	
<19	1
20-29	9
30-39	27
40-49	34
50-59	23
>60	6

Table II. Respondents' basic demographics

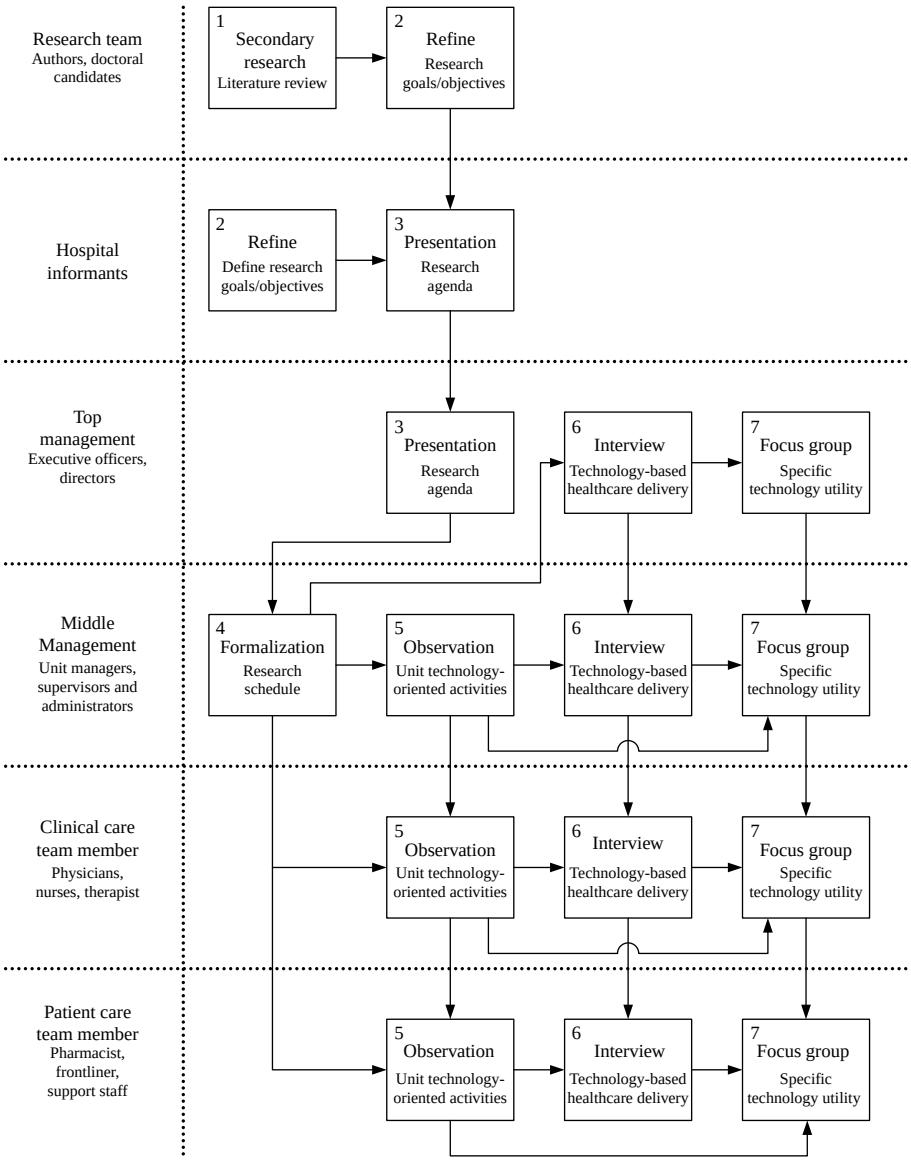

Figure 1.
Field study of technology-based healthcare delivery

The boxes are numbered to indicate the systematic field studies process, consistent with grounded theorists' recommendations on conducting field research (Corbin and Strauss, 1990; Kaghan *et al.*, 1999).

The researchers reviewed secondary data and published materials such as annual reports, newsletters, department minutes, and project documentations before formal meetings with any hospital personnel. Based on the secondary research, a list of semi-structured questions was developed with input from key informants and two

members of top and middle management. To solicit feedback for improvement, the research objective and implementation process were disseminated to selected department unit managers. The research team remained open minded to suggestions but adopted a systematic approach to refine the interview questionnaire prior to presenting the research agenda at department meetings and discussing it with hospital employees.

The field studies were conducted through observations, semi-structured interviews, and focus group discussions. With the help of unit managers, a list of things to be observed was created and the research team was able to observe all scheduled events except a few when no outsiders were allowed during clinical procedures. We observed how employees used CT scan, laboratory systems, and many other tools and machines on a daily basis, and how these technology-oriented results were being input into the EHR systems. We choose to focus on EHR instead of various IT or clinical systems for three reasons:

(1) This is an emerging topic that concerns all healthcare service providers.

(2) The level of usage signifies the degree of technology-oriented activities.

(3) The designing, planning, implementation, and communication of such system provide many indications of strategic goals on technology-based decisions.

Frequently, an observation in one department led to visits to other departments when researchers sought to find insights into unexplained phenomena. For instance, a machine was in one department but removed to another area during the next visit. The machine was heavy and it is expected that people who wanted to move it had to produce good reasons for the move. The researchers interviewed the departments involved and tried to find out if any employees were affected by the proximity of the machine and how they perceived the change, since the department that originally had that machine would likely be inconvenienced. Consistent with grounded theory guidelines, the researchers looked for context, causal conditions, and intervening situations in every observation (Strauss and Corbin, 1990).

The semi-structured interviews and focus group discussions were scheduled by hospital coordinators to cover as many available interviewees as possible in similar service areas on a given day. Tape recorders were used whenever permission was granted, otherwise researchers took notes during all interview sessions. The interviews allowed respondents to elaborate on topics and raise any issues or concerns. At the end of the day, researchers met to exchange notes, recollect impressions, and verbalize unique observations.

Coding

The coding stages involved open, axial, and selective coding. Open coding started with a full transcription of an interview and a review of notes line by line to identify words or phrases that carry distinct "thought units" (Ashill *et al.*, 2003). In essence, the process attempts to pull out a "chunk" of data or information that represents or belongs to, some general phenomenon (Goulding, 2000). Axial coding refers to the process through which researchers pull together all strands in order to offer an explanation of the actions and behaviors under study. Lastly, during the selective coding process, the researchers met over a three- to four-month period, trying to find common ground to agree on core categories that represent the central phenomenon of the study (Corbin and Strauss, 1990).

Research findings

After the collection of a series of grounded events and incidents, the data were analyzed to find common themes that represented substantive theory. Applying a method proposed by Huberman and Miles (2002) to ascertain coder agreement in qualitative analysis, we observed 85 percent agreement between two researchers on level of convergence. This implies that the coding agreement is excellent for theme meaning, prominence, and supporting examples on the field studies. The findings reveal that TECHOR is institutionalized as a result of its demonstrated effectiveness in delivering patient-centered services with improved cost effectiveness, efficiency, quality control, and safety. A sample of respondents' comments and interpretation is presented in Tables III and IV. Below, we will discuss the driving forces and consequences.

Driving forces of TECHOR

The research team found that the push for technology-enabled care coordination, administrative, and business operations derives from two interrelated, external and internal forces. The external forces consist of the competitive and institutional forces. Competitive forces stem from the need to stay competitive as a hospital system that provides state-of-the-art health services. One revealing anecdote on the emerging move towards adoption came from the IT development manager: "Ask any clinical director about their EHR systems experience compared to our competitors," he said, "you will find that all units have deployed at least some sub-systems because they are 'pressured' to install these systems faster than our competitors." As for the institutional forces, the Institute of Medicine's Quality Chasm report highlighted the potential value of IT in improving the quality, safety, and accountability in healthcare delivery (Institute of Medicine, 2001). Consistent with the Institute of Medicine Task Force's recommendation, the participants provided examples on how online and 24/7 access to comprehensive medical information can facilitate informed decisions, improve the quality of care, and reduce medical errors.

We also found out that the most recent federal stimulus package has emerged as a catalyst of institutional forces. The American Recovery and Reinvestment Act of 2009 approved $19.2 billion for healthcare providers to adopt HIT over a five-year period. Medicare and Medicaid physicians who implement and report meaningful use of certified EHR will be eligible for an initial incentive payment up to $18,000 (American Medical Association, 2009; Bates, 2009; National Governors Association, 2009).

Strategic goals and needs for compliance represent the two internal forces that drive the adoption of technological tools to empower day-to-day operations. First, the top management revealed plans for organizational-wide implementation of EHR systems and strategic alliances with other healthcare providers in the next three years. Strategic goals are defined based on economic incentive, change process, technological advances, and resource availability. They involve defining minimum requirements to be satisfied in order to assure overall success. For example, the EHRs must be capable of submitting to a practice management system accurately or the implementation would fail. Second, the needs to comply as expressed by a number of senior physicians, were due to the amount of paper work that must be recorded or providers would face the risk of litigation. These physicians stated the amount of documentation had exploded since they were junior doctors. Physicians were unable to keep track of everything without technological tools. Therefore, they adopted IT solutions as coping mechanism. A summary of respondents' comments related to the driving forces is listed in Table III.

Forces	Comments	Expanded explanation
Competitive forces	"To be successful in the laboratory outreach business, we must have a competitive IT connectivity. Otherwise, the big national labs take all the good business from all the multiple-doctor groups, and we are stuck with the small doctor offices that are high maintenance and low profitability." – Outreach Director	The major national laboratories such as Quest Diagnostics, and Laboratory Corporation of America Holdings (Lab Corp.) provide online order entry that can be interfaced with the clinics' electronic medical record. Physicians order in their electronic medical record, the orders cross over to the national labs, and the results flow back to the electronic medical record
	"What I can tell you is do more, know more, and you have to do it faster, know everything in your finger tips. Just when you are wondering how you can do so many, you realized that your competitors already do them all. How? They made the computers do everything. The game now is see who can act quickly and move faster." – Senior Administrator	Healthcare organizations are computing on building competitive systems to converge of data, image, voice, and other media for ultimate system integration in managing health. With broadband access, information flow efficiently in a single pipeline
Institutional forces	"We don't have any choice now; the current reimbursement [requirement] is tied to performance. Physicians can no longer order any tests because if the insurance rejects payment, the hospital has to absorb the cost. We can't tell doctors what they can and cannot order, but the system can." – Billing Manger	Third-party and Medicare denials delay payments for tests to clinics and increase the days sales outstanding. Inappropriate diagnostic coding for tests by physicians result in considerable additional billing costs
	"Physician quality reporting initiative, which is also referred to as 'pay for performance' is a program developed by the Centers for Medicare and Medicaid Services-Medicare as a way of having medical practices report more detail on patient progress and outcomes. Medicare will pay up to an additional 1.5% in reimbursement when the number of eligible encounters reported with Physician Quality Reporting Initiative codes is 80% or more. We are able to participate in the diabetic control measure of Hemoglobin A1c and reported 90% of our encounters, provide better care to our patients and also achieve a financial incentive." – Physician	The Tax Relief and Health Care Act of 2006 authorizes the Centers for Medicare and Medicaid Services to establish and implement a physician quality reporting system. In response to this mandate, the Centers for Medicare and Medicaid Services created the physician quality reporting initiative to provide a financial incentive for eligible professionals to participate in a voluntary quality reporting program. Eligible professionals who successfully report a designated set of quality measures on claims for dates of service may earn a bonus payment, subject to a cap, of 1.5 percent of total allowed charges for covered Medicare physician fee schedule services
Strategic goals	"Being a large healthcare systems means we must have the technologies to provide quality care. Our goal is let our care teams and patients to have access to the front edge of technology." – Hospital Administrator	The results from the patients and employees satisfaction survey indicate that technology-enabled services is one of the major determinants for satisfaction. The patient service unit often received feedback and suggestions for new web-based services

(*continued*)

Table III.
Driving forces of TECHOR

Table III.

Forces	Comments	Expanded explanation
	"One of the goals for the primary care physicians is to provide better care for our diabetic patients. We are able to participate in the diabetic control measure of Hemoglobin A1c and reported 90% of our encounters, provide better care to our patients and also achieve a financial incentive." – Physician	Every clinical unit sets its own goals and monitor the success of technology initiatives. The results were shared in department meetings and used it to brainstorm for new marketing ideas or create complimentary services
	"Our EHR development team comprises a group of architecture developers who understands the hospital systems' strategic business objectives and ensure that our technology initiatives mapped those of a technology life cycle management plan." – IT Application Manager	Healthcare providers must manage the growing demands of their business with IT resources that are often spread too thin. By prioritizing what types of technologies should be deployed according to needs and their relative life cycles, providers are able to maximize their technology investment in satisfying greater number of needs
Needs for compliance	"The computerized advice on allergy checks, drug doses, drug-drug interactions, and treatment periods are there, with just one click." – Resident Doctor "If we 'do it right'. No one should order more or less tests, we must order what is considered 'appropriate' by the system. One way to 'do it right' is to use 'Computerized Physician Order Entry' and avoid hassle." – Nurse	When computerized physician order entry is coupled with clinical decision support, research at leading academic medical centers has shown that medical errors may decrease and costs often drop. The system helps providers to stay compliant with the Joint Commission, formerly the Joint Commission on Accreditation of Healthcare Organization
	"Every month they gave us (these) reports and tell us how much we spent, what are the uncollected bills, etc. Initially I tried to change my ordering based on my own decisions. I still got rejected bills. Now I let the Clinical Decision Support does it, and I don't have to worry. So now my goal is to reduce rejection rates for the entire department." – Clinical Head of Department	The heads of all units were given monthly benchmarking report with quality measures, target goals and gap analysis. Although the intention of circulating the report is for monitoring purposes, some units manager use it creatively to narrows the service gaps and motivate staff for higher compliance

Outcomes	Comments	Expanded explanation
Patient centered	"We worked with other institutions like the HMO and Cancer Research Network to pool research data and capabilities to develop evidence-based best practice." – Cancer Center Research Coordinator	The goal is to obtain important insights from a large pool of data and use such information to develop healthcare protocols and better health management practices
	"*My Chart* has been a great patient satisfier." – Patient Care Coordinator	My Chart is a secure online health connection that allows patients direct access to their health record. Patients can look up their health information, view lab results and other test results released by their physicians, allergies, medication and physicians instructions. They can renew their prescriptions and schedule or cancel appointments
Cost effectiveness	"Comprehensive order sets were developed with department experts. When an order is placed, a validation check is performed prior to order transmittal to ensure that the test had valid clinical indications. An alert displays if the orders are placed with inappropriate diagnosis codes"	Insurance denials delay payments for tests to clinics and increase the days sales outstanding. Inappropriate diagnostic coding for tests by physicians result in considerable additional billing costs. To avoid these problems, computerized physician order entry was used to validate order "legitimacy"
Efficiency	"It is impossible to remember which tests and procedures require Advanced Beneficiary Notices because of the frequent Medicare rules changes. ABN alerts have simplified my job; I don't have to look up a long list each time." – Frontliner, Patient Care	Medicare has a set of rules to determine if certain tests, services, and procedures will be covered. These coverage rules are based on medical condition and, sometimes, on the number of times that a patient had a particular test, service, or procedure in the past. An advanced beneficiary notices must be given each time a healthcare provider believes a service will not be not be covered by Medicare if the provider wishes to bill the beneficiary directly for the service If a test or procedure is denied for lack of medical necessity and an ABN is not given to the beneficiary, the provider is required to refund to the beneficiary any amounts already collected for the denied service
	"Although individual order sets are not permitted, we have preference lists that make ordering easy. We also have Smart Tools that include Smart Text, Smart Links, Smart Phrases and Smart Sets. Once I insert a Smart Text into a patient's chart, patient values are automatically populated. This simplifies my progress notes during rounding [refers to physician goes into inpatient wards to see patients]." – Physician	Preference lists are individually customized lists of medications, laboratory tests, radiology, and other interventional procedures that physicians most commonly order. Research has shown that entering orders electronically takes longer than handwriting or giving verbal orders. By improving provider efficiency, preference lists can improve provider acceptance of computerized physician order entry. Smart text, smart links, and smart phrases are tools that simplify the task of documentation

(*continued*)

Table IV.
Comments and interpretation of evidence-based outcomes

Table IV.

Outcomes	Comments	Expanded explanation
Quality control	"To meet National Patient Safety Goal 3E for anticoagulation, a team of pharmacists, nursing leaders, dietitians, physicians and lab staff drew up protocols for initiating warfarin, unfractionated heparin and low molecular weight heparins. This includes lab tests, therapeutic ranges for different clinical situations, dietary advice, patient education and discharge instructions. Standardization of protocols has allowed pharmacists to manage this group of patients." – Pharmacy Director	Protocols and standing order sets help clinicians quickly select appropriate doses, routes, and other parameters when ordering medications. Thus, these tools may also reduce the risk of errors that can lead to adverse drug events, and they can serve as guidelines for care when the therapy is initiated by nurses or pharmacists
	"Order sets were a major area of focus. We have order sets for many of the common conditions – heart failure, chest pain, sepsis. Personal order sets are discouraged. For example, our myocardial infarction admission order set includes EKG and lab tests and when to repeat them, chest X-rays, commencing medications like beta blockers, aspirin, plavix, pain management, etc. It even has reminders such as withholding beta blocker when the heart rate is slow or nitroglycerin when Viagra or Cialis have been taken within the past 24 hours. It is easy to omit a test or get a complete history from the patient on a busy day." – Emergency Department Medical Director	Standardized order sets within computerized physician order entry offer hospitals several benefits, not the least of which is the availability of legible, complete, and structured physician orders to users throughout the facility. Order sets also provide physicians with all relevant orders and reduce their reliance on memory – a standard patient safety principal The use of order sets can also decrease the risk of medication errors and adverse drug events. The inclusive nature of electronic order sets can reduce omission errors, and by defaulting to evidence-recommended doses, order sets can guide physicians in writing appropriate orders
Safety	"Today's (the practice of) medicine is way too complex and it exceeds the limitations of unaided human mind. It is impossible to remember all 10,000 randomized controlled trials and their results." – Physician	Providers are relying on EHR systems instead of their memories to keep up with best practices, some of which are related to the latest medical breakthroughs from the most recent, yet to be published trials
	"I am surprised by the number of patients that were unable to recall any of the medications they take on a regular basis. The patients who were able to remember their medications often were not sure why they were taking the drug, when they started taking it or at what dose and frequency they take the medication." – Physician Assistant	Medical reconciliation is a 2006 national patient safety goal. The first part of medicines reconciliation on hospital admission is to ensure that medicines prescribed on admission correspond to those that the patient was taking before admission. Details to be recorded include the name of the medicine(s), dosage, frequency, and route of administration. The second part requires that the patient and the patient's care providers receive an accurate list of current medications upon discharge

Evidence-based outcomes

The adoption of EHR enabled a series of evidence based as observed across various facilities at the participated hospitals. The study found that the adoption of TECHOR was related to three major lines of activity: hospital administrative, business functions, and outpatient services. Healthcare professionals are able to provide coordinated healthcare when they adopt technology to manage the needs of their patients. This is because the technology system empowers clinical and care team members with expanded knowledge and capabilities, allowing users to make decisions more quickly and confidently. Below, we present a patient-centered outcome with demonstrated benefits of cost effectiveness, efficiency, quality control, and safety. A summary of respondents' comments and expanded explanation is listed in Table IV.

Patient centered. The Institute of Medicine proposed that development of EHR systems be patient centered aimed at providing responsive health services and being respectful to patient preferences and needs (Institute of Medicine, 2001). Consistent with Institute of Medicine's expectation, the respondents' responses we obtained included: "patients want to know their health results quickly [. . .]" and "patients would benefit if we do this [. . .]". The development team members explained the importance of including all users in the planning of each different EHR subsystem before a vendor was selected. In addition, the requirements among various units must be understood because a 150-physician multi-specialty group may have features that are very different from a 30 cardiologists group. Thus, the development team strived not to operate in "silos" by getting inputs from the physicians, and matching their expectations with those of patients. The goal was to build comprehensive systems that provide a safer healthcare experience, that are more reliable and responsive to patients needs, have higher integration and accessibility so that patients could receive the full array of preventive, acute, and chronic services that are proven to be beneficial.

Cost effectiveness. Consistent with previous studies, cost effectiveness is achieved through evidence-based medicine and financial incentive via proper administration and appropriate utilization of technological systems (Hillestad *et al.*, 2005). An evidence-based medicine cost effectiveness is realized by expanding evidence on the most reliable practice patterns, physicians at the point of care can apply such evidence as a basis for evaluating care plan. The systems dissuade clinicians from practicing wasteful "defensive medicine" such as excessive test orders and unnecessary use of drugs (e.g. antibiotics) because physicians can now rely on clinical decision support artificial intelligence for drug alerts in relation to treatment (Studdert *et al.*, 2005). Financial incentive, on the other hand, is demonstrated by substantial reduction of insurance denials by at least one SD from before the implementation. Two interviewed billing analysts provided data of two units' reduction of insurance denials: colonoscopy decreased by 29 percent and MRI/MRA decreased by 37 percent. The number of test ordered for these two units did not change.

Efficiency. Efficiency is achieved through streamlining operation processes and elimination of man power hours. The physicians argued that in the past they spent countless hours of staff time searching, moving, and managing paper charts. After EHR implementation, efficiency is achieved through the use of:

- internet-based communication; and
- rule-based clinical decision support of widely accepted medical practices with proper references and citations.

The internet-based communication allows all clinical and care team members to obtain critical medical information about their patients as soon as it is needed. It drastically reduced the amount of time spent searching for files, and the common platform makes it easy to review patients' medical histories. The rule-based clinical decision support is a form of artificial intelligence physicians have grown to rely on them. According to some resident doctors we interviewed, the clinical decision support is like a "walking medical encyclopedia", it encompasses almost every treatment condition. Efficiency is essential when treating people admitted to the emergency department in great distress or unconscious, and assists treatment of economically disadvantaged patients who may not have primary care physicians to manage their care, and those who cannot fully recall or understand the details of their medical histories (Baron *et al.*, 2005).

Quality control. As advocated by Institute of Medicine, quality control is obtained through IT-enabled preventive medicine by delivering health services in a consistent manner with minimum variations in treatment plans. According to the quality control employees, the harnessing of information from credible sources enhanced medical care to patients as network partners align activities with pre-defined standards and baseline quality. Prior to EHR implementation, a blue print with identified quality control features to be embedded in clinical decision support' medical diagnosis and treatment management was reviewed by clinical and care team members, to assess its potential usefulness and stability within the infrastructure. The IT engineers also pointed out increasing the assortment of web-based services with reporting tools is a recurring theme of monitoring activities to identify and control "service defects". Consequently, a reliable set of quality measures are employed at a global level for the entire hospital system.

Safety. Safety is achieved primarily from the computerized physician order entry's safety features. The computerized physician order entry is paired with the rule-based clinical decision support to help prevent clinicians' errors or oversights before they cause harm. The clinical decision support suggests default value for drug doses, frequency and routes of administration, and may offer more sophisticated drug safety features. It works hand-in-hand with computerized physician order entry to decipher illegible handwriting, transmit orders directly to pharmacy, and facilitate faster pharmacy responses thus promulgating best medical practices. The interviewed pharmacists pointed out that dispensing errors was down by 15 percent during the first quarter of implementation. Physicians at the participating hospital system emphasized the benefits of alert features such as prompts suggesting the physician to order a blood glucose or corollary testing when insulin is prescribed. Through many rounds of testing, physicians discovered and suggested more safety features to be added, and made adjustments to the safety alerts.

A framework of TECHOR

In this paper, we explored technology-oriented practices through the study of EHR within a large-scale hospital system. We examined the important roles of technology in relation to the delivery of a safe, efficient, reliable, and quality services. Using a descriptive, exploratory grounded theory approach, we studied the driving forces and evidence-based outcomes of TECHOR over a two-years time period. Iterative interplay between data collection and analysis allows for the emergence of concepts directly from the language and perspectives of the 128 participants. Subsequent integration of these

concepts with literature interpretation results in a proposed framework that is "grounded" in the realities as shown in Figure 2.

The antecedents of TECHOR comprise of external and internal forces. Competitive forces and institutionalized movement represent the prevailing forces that push organizations to formulate their strategic goals, realign priorities to meet the needs for compliance. Together, these two driving forces lead to the adoption of a TECHOR approach in managing administrative complexity, business functions, and the practice of evidence-based medicine. As shown in Figure 2, this study found that effective adoption and appropriate use of EHR were positively led to a patient-centered healthcare delivery that yields four tangible outcomes:

(1) cost effectiveness;

(2) efficiency;

(3) quality control; and

(4) safety.

These intended outcomes reap from the ability to leverage technology for a seamless and consistent service delivery that is patient focused. Ultimately, the art of aligning internal goals, balancing competing priorities, utilizing available resources, and managing demand and expectation, is imperative to successful adoption of a TECHOR approach.

Discussion

In the foreseeable future, all paper-based patient records and medical files contained in thick binders and stored on shelves are likely to be gone. The UK and the US Governments, along with private organizations are enthusiastically promoting the adoption of HIT, such as the EHS systems as means to streamline, transform, and enhance healthcare delivery. Most importantly, reducing healthcare expenditures and providing safe and quality health services are becoming priorities globally (Wickramasinghe, 2000). One way to achieve these goals is to digitize health information and store it on online repositories. Internet-based tools allow providers to collect data and provide decision support information while patients are being cared for and deliver immediate feedback. By adopting various HITs, healthcare providers have institutionalized TECHOR in managing daily routine and operation processes.

Our research findings indicate that the participating hospital system has made huge strides in adopting EHR systems for various hospital administrative and business functions, as well as managing evidence-based medicine practices. The emerging

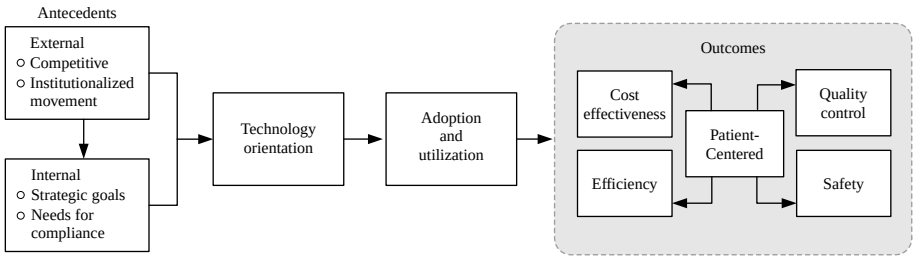

Figure 2.
TECHOR antecedents and outcomes

powerful forces coming from the competitive environment and federal government are pushing all healthcare organizations to rethink their technology strategies, prioritize and realign goals to meet their needs for compliance. As many patients are now using the internet to retrieve health information, interact with healthcare partners, and order pharmaceutical products, they expect hospitals to provide online assistance via integrated technologies. A careful understanding HITs allow healthcare providers to design an efficient patient-centered delivery system that communicates, interacts, and fulfills consumers' needs. The realization of potential benefits might not always come with the adoption of EHR systems; the structure, and therein the capabilities and utility, of the data repositories and the clinical decision support are all important in determining how much users can learn in real time, and how much of this learning would result in actual adoption and utilization (Steenhuysen, 2009).

Strategic implications

Many large-scale hospitals systems and medical centers are reputed to provide technology-enabled high-quality care in managing day-to-day operations, treating rare diseases and complex conditions, and providing specialized services and advancing biomedical research. Some services, such as frontier surgeries, transplants, and radio therapies, are predominantly offered through the use of sophisticated medical technologies. The adoption of hospital technologies is widely recognized as a strategic vehicle to generate competitive service value. Many studies have documented that hospital technologies help to improve clinical outcomes and treatment process, in addition to major value improvement in the healthcare delivery (Porter and Teisberg, 2006). Notwithstanding its potential effectiveness, understanding the concept of TECHOR is crucial to:

- developing and planning of technology initiatives;
- creating new services to meet evolving demands; and
- establishing long-lasting competitive advantage.

First, technology investment must be carefully managed in order to deploy useful HIT resources for different technology initiatives. The return on investment for an EHR is based on the assumption of improved productivity and efficiency that will lead to substantial cost savings. In cases where EHR is used, its intrinsic value has proven to benefit patient care beyond the bottom line (Steenhuysen, 2009). Second, today's health consumers are well informed through the use of internet and web-based technologies. Healthcare organizations' ability to expand and transform services come under scrutiny for their effectiveness in meeting new and evolving demands. From online access to interactive connectivity, health consumers are asking for more values for less cost, less waiting time for more services (Steinbrook, 2008). Lastly, the adoption of technology does not automatically link to competitive advantage. Some organizations are better able than others in managing their resource base by adding, reconfiguring, and moving resources to generate sustainable advantage (Danneels, 2008; Eisenhardt and Martin, 2000). Understanding the proposed framework of would allow organizations to determine the appropriateness of technology-oriented practices and better manage technology initiatives in five major ways as follows.

First, organization can prioritize the adoption process by allocating resources to the units that have greater needs; some units would benefit more with the adoption of new

technology because the old processes are obsolete and problematic. Second, potential failure can be avoided by studying existing workflow and understanding how new technology can be utilized without creating a new set of problems. Third, unit managers can better manage employees' reactions by listening to their concerns and providing necessary training. Fourth, patients' sentiments and responses can affect the success of any technology implementation. Frontline employees who have frequent interaction with patients can help to collect critical information that must be considered before implementation. Lastly, organizations can create values and establish competitive advantage via appropriate implementation of technologies.

Future research directions

The US Federal Government's ultimate goal is a fully interoperable EHR system which will first operate on a regional basis using regional health information organizations, and eventually transform into the National Health Information Network. Therefore, EHR is an emerging topic that warrants more in-depth discussions and there are many avenues for future research.

First, the negative consequences of EHR must be examined. Notwithstanding the fact that a carefully conceptualized EHR system can save lives, prevent medical errors, and reduce costs of unnecessary procedures, a number of issues remain unresolved. Affordability and privacy are major concerns not explored in this study. Second, culture and leadership are important criteria for embracing an electronic-based healthcare delivery. Healthcare providers must be comfortable with expert systems' recommendations, which may conflict with their training and self-reliance. The use of so-called "cookbook medicine" assisted by clinical decision support may be perceived with suspicion and, thus, a balanced approach must be achieved. Third, there are many human factors related to institutionalize TECHOR that are not discussed in this paper. They include organizational support of medical staff acting in the best interests of patients at the most appropriate time, and the involvement of patients and third parties. These topics should be addressed in future research.

Lastly, the current study aims to shed light on a timely healthcare topic because technology adoption can impact the cost of healthcare. Despite the content of this current study is in healthcare, we suspect our findings would be relevant for a wide range of service industries. To verify its generalizability, it is essential to duplicate the current study in other research setting, further investigate, and conduct similar observations.

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