Effective implementation of health information technologies in U.S. hospitals

Naresh Khatri
Vishal Gupta

Objectives: Two issues pertaining to the effective implementation of health information technologies (HITs) in U.S. hospitals are examined. First, which information technology (IT) system is better—a homegrown or an outsourced one? In the second issue, the critical role of in-house IT expertise/capabilities in the effective implementation of HITs is investigated.
Study Design/Data Collection: The data on type of HIT system and IT expertise/capabilities were collected from a national sample of senior executives of U.S. hospitals. The data on quality of patient care were gathered from the Hospital Compare Web site.
Findings: The quality of patient care was significantly higher in hospitals deploying a homegrown HIT system than hospitals deploying an outsourced HIT system. Furthermore, the professional competence and compelling vision of the chief information officer was found to be a major driver of another key IT capability of hospitals—professionalism of IT staff. The positive relationship of professionalism of IT staff with quality of patient care was mediated by proactive employee behavior.
Conclusion: A homegrown HIT system achieves better quality of patient care than an outsourced one. The chief information officer's IT vision and the professional expertise and professionalism of IT staff are important IT capabilities in U.S. hospitals.

Health information technologies (HITs) consist of an enormously diverse set of technologies for transmitting and managing health information for use by consumers, providers, payers, insurers, and all other groups with an interest in health care (Blumenthal & Glaser, 2007). Health care providers are implementing HITs, such as electronic medical records (EMRs) and computerized physician order entry, rapidly in response to the American Recovery and Reinvestment Act of 2009, which has set aside up to $30 billion in incentive payments to support the adoption and "meaningful use" of electronic health records and other types of HITs (Blumenthal, 2011; Kaushal & Blumenthal, 2014). The number of certified HIT vendors in the United States has mushroomed from 60 to more than 1,000 since mid-2008 (Sittig & Singh, 2012). Many experts, however, express major concerns that the easy availability of federal funds

Key words: electronic medical records, health information technologies (HITs), information technology (IT) capabilities, proactive employee behavior, quality of patient care

Naresh Khatri, PhD, *is Associate Professor, Health Management and Informatics, University of Missouri School of Medicine, Columbia. E-mail: khatrin@health.missouri.edu.*
Vishal Gupta, PhD, *is Assistant Professor, Organizational Behavior, Indian Institute of Management Ahmedabad, Vastrapura, India.*

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under "meaningful use" may result in rushed or poor implementation of HITs without comprehensive functionality and processes in place, thus causing substantial and unexpected risks in health care delivery (Black et al., 2011; Furukawa, Raghu, & Shao, 2010; Klauer, 2013; Nanji et al., 2011; Pines, 2013). For example, Furukawa et al. (2010) reported that the associated increase in staffing and decline in patient safety with the introduction of EMRs in their study might have been because of poor implementation of EMRs, among other factors.

It is plausible that the provision of "meaningful use" in HITECH may merely prop up the HIT market without improving quality (Klauer, 2013). Even worse, this may end up saddling health care providers with dysfunctional HITs that would be hard to change or replace later (Pines, 2013). Although optimal computerization is likely to improve quality, it remains unclear whether the systems currently deployed in most hospitals achieve such improvement (Himmelstein, Wright, & Woolhandler, 2010). For example, Fernandopuule and Patel (2010) observe that HIT systems in U.S. hospitals are poorly designed for the kind of team-based, proactive, patient-centered care that the patient-centered medical home and other models are calling for, rather the very core structure of the current health records is at odds with the notion of creating the continuous, seamless patient care. Instead, electronic systems are primarily driven by the imperative to allow doctors to document code and bill visits at a more intensive and, thus, higher-paying level. Although these features allow for increased practice revenue in a fee-for-service setting, they do nothing to improve care.

Undoubtedly, HITs are a powerful tool and have a great potential to transform health care (Blumenthal & Glaser, 2007). The pertinent question is how to get them right (Feld & Stoddard, 2004). For example, by leveraging IT investments during the 1990s, banks saw a 25% reduction in branches and a 20% reduction in full-time employees (Blount, Castleman, & Swatman, 2005). In health care, the capacity of HITs to realize the transformational vision envisaged in health care reform depends largely on whether the systems installed are designed to produce the information required to make possible the quality and cost reforms that are sought (Blumenthal & Glaser, 2007). Unfortunately, current HITs are not configured properly and do not sufficiently support aspects of care delivery that are vital to improving care and controlling costs (Jones, Heaton, Rudin, & Schneider, 2012). We contend that it has happened at least partly because health care organizations have not built the necessary in-house IT expertise, which we believe is a must for getting HITs right.

In this study, we examine two relatively unexplored but important issues pertaining to the effective implementation of HITs. First, we consider what kind of an IT system is better, a homegrown system or an outsourced system offered by vendors such as Allscripts, Cerner, Epic, GE, or Misys? Second, we argue that the effective implementation of HITs depends significantly on IT expertise/capabilities of hospitals.

Theoretical Background and Hypotheses

The conception of IT capabilities developed in this study is premised on two related theoretical frameworks of resource-based view and dynamic capabilities that have received much attention from strategic management scholars in the last two decades (see Barney, Ketchen, & Wright, 2011; Teece, 2007). Several studies espousing the resource-based theory and dynamic capabilities show that IT investments produce operational improvements *only when* they are accompanied by the development of effective IT capabilities/expertise (Lu & Ramamurthy, 2011; Mithas, Ramasubbu, & Sambamurthy, 2011; Yeh, Lee, & Pai, 2012). IT capabilities of an organization enable it to acquire, deploy, and adapt IT-based resources to improve organizational processes and performance (Yeh et al., 2012). Ross, Beath, and Goodhue (1996) argue that an enterprise is successful not because of any particular leading edge IT applications, but because it has developed a capability for applying IT to ever-changing business opportunities. In the absence of internal IT capabilities, health care entities tend to return to the old paper-based method or use partial information recorded in both systems (Curry & Knowles, 2005), which results in loss of information, increased time for retrieving pertinent information/data, and need for more IT staff.

IT should be organized around business processes rather than the other way around (McAfee & Brynjolfsson, 2008), and HITs are far more complex to implement than typical health technologies such as a new medical device or a new medical procedure (Tyagi, Cook, Olson, & Belohlav, 2013). Unfortunately, in health care, the IT initiatives seems to be more concerned with technical aspects, in the process ignoring the vital contextual factors that make or mar IT projects (Khatri, Pasupathy, & Hicks, 2012). This happens because typical health care providers lack sufficient IT expertise, and as a result, they approach IT projects in a somewhat simplistic manner, just like other health technologies (Kellermann & Jones, 2013; Kivinen & Lammintakanen, 2013; Mandl & Kohane, 2012).

Lu and Ramamurthy (2011) found that when IT spending is not properly channeled into IT capability, greater IT spending has a negative effect on organizational agility, suggesting that IT capability is critical in realizing greater organizational agility. This finding underscores the contention that huge, imprudent IT investment is not necessarily beneficial to organizational agility in responding to market changes. This may be a result of the wrong infrastructure or incompatible systems, delayed and rushed implementations, or islands of automation meeting local needs without integration across the enterprise.

Next, we develop three sets of hypotheses. We look at the relative efficacies of homegrown and outsourced HIT systems in the first set. In the second, we propose relationships among dimensions of IT capabilities. In the last set, we suggest that the relationship of IT capabilities with quality of patient care is not

direct but mediated by proactive employee behavior. A model depicting the hypothesized relationships is shown in Figure 1.

Which Is Better: A Homegrown or an Outsourced HIT System?

The approach of health care providers in the implementation of their HIT systems varies. Some have implemented internally developed HIT systems. Some others have implemented HIT systems offered by IT vendors such as Allscripts, Cerner, Epic, GE, and Misys. There are still others, although a small number, that have yet to introduce any HITs in a major way. There is dearth of research examining the relative effectiveness of internally developed and outsourced HIT systems.

A disproportionate amount of health care literature on the realized benefits of IT comes from a small set of early adopter institutions that implemented internally developed HIT systems (Chaudhry et al., 2006). These institutions had considerable expertise in HITs and implemented systems over long periods in an incremental, iterative fashion. Examples of health care institutions developing their own effective HIT systems include Brigham and Women's Hospital/Partners Health Care, the Department of Veterans Affairs, and LDS Hospital/Intermountain Health Care.

The complexity of health care delivery coupled with the extent to which HITs permeate the entire health care delivery process makes implementation of HITs one of the most formidable tasks. The effects of HITs are influenced by various organizational factors—especially the availability of IT expertise, among others (Kaushal & Blumenthal, 2014; Khatri, 2006). It comes as no surprise that most health care providers are struggling in implementing HITs effectively. The outsourced HIT systems have a tendency to "airdrop" ITs without concomitant changes in organizational cultures and management systems (Khatri et al., 2012; Kivinen & Lammintakanen, 2013). However, computerization is not simply buying computer hardware; instead, it involves a broader collection of complementary investments and innovations, some of which take years to implement (Brynjolfsson & Hitt, 2003; Jones et al., 2012). Consequently, the benefits of HIT investments have not been realized fully in health care thus far and will remain elusive unless HITs are properly configured and embedded in the health care delivery process (Kellermann & Jones, 2013; Nanji et al., 2011).

McCormick, Bor, Woolhandler, and Himmelstein (2012) observed that the off-the-shelf commercial systems are often chosen because of billing concerns and more closely allied with the needs of administrators than those of clinicians. Furthermore, the outsourced HIT systems are unlike highly customized systems developed by on-site IT experts who are closely integrated with the clinical staff. It comes as no surprise that internally developed HITs tend to be configured and embedded in the clinical process better than outsourced HITs. Thus, it would seem that the quality of patient care is likely to be higher for health care providers deploying an internally developed HIT system than those deploying an outsourced one.

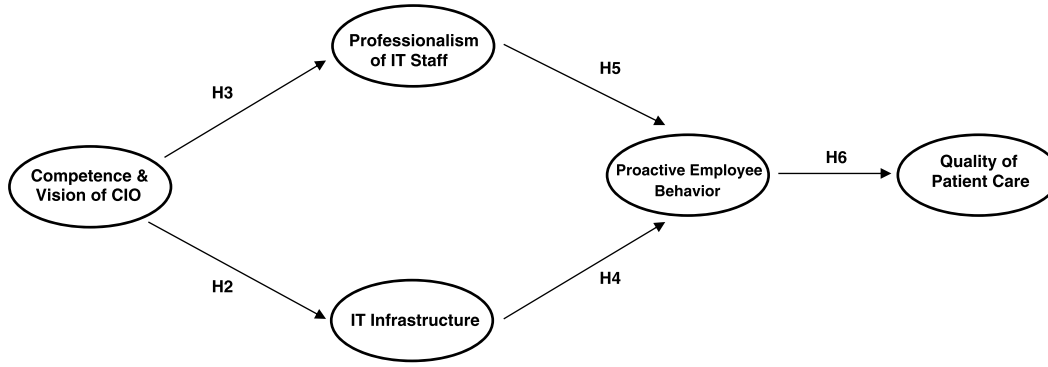
> *Hypothesis 1:* The quality of patient care of health care providers deploying an internally developed HIT system is significantly higher than those deploying an outsourced HIT system.

Relationships Among IT Capabilities

IT capabilities consist of three basic dimensions: (a) IT infrastructure, (b) professionalism of IT staff, and (c) vision and competence of the chief information officer (CIO; Bassellier & Benbasat, 2004; Khatri, 2006; Mithas, Ramasubbu, &

Figure 1

The hypothesized model



Note. IT = information technology; CIO = chief information officer.

Sambamurthy, 2011; Peppard, 2010). The first dimension of IT capabilities is the underlying IT infrastructure. IT infrastructure helps health care organizations identify and develop key applications of IT for improving business processes rapidly; share information across services, locations, and specialties; and facilitate implementation of transaction processing and supply chain management (Lu & Ramamurthy, 2011; Mithas, Ramasubbu, & Sambamurthy, 2011).

Professionalism of IT staff (IT staff having necessary technical, behavioral, and business skills) makes the second dimension of IT capabilities (Fink & Neumann, 2007). IT professionals refer to the quality of employees in the IT department. For implementing IT initiatives effectively, IT professionals (and thus IT departments) must possess technical and interpersonal skills, communicate effectively with employees and managers in other units, be conversant with change management, and have requisite expertise for conceiving and developing cost-effective applications of IT to support clinical and business needs of the organization (Bassellier & Benbasat, 2004).

The third dimension of IT capabilities consists of the CIO's professional competence and vision for IT. The savviness of the CIO is thought to be pivotal to the realization of IT value in health care organizations (Broadbent & Kitzis, 2005; Burke, Randeree, Menachemi, & Brooks, 2008; Peppard, 2010). Thus, the CIO being an important member of the top management team, he or she having an excellent technical expertise and a compelling IT vision for the organization, he or she developing great rapport with heads of other units and departments, and he or she having necessary leadership skills and business acumen are all crucial.

We believe that the CIO's IT vision and competence is likely to be the main driver of other two IT capabilities, IT infrastructure, and professionalism of IT staff. This is because the CIO, as in-charge of IT function, makes decisions regarding what ITs to acquire and what IT professionals to hire. Thus, the following hypotheses:

Hypothesis 2: The CIO's IT vision and competence is positively associated with IT infrastructure.

Hypothesis 3: The CIO's IT vision and competence is positively associated with professionalism of IT staff.

Relationships of IT Capabilities With Quality of Patient Care

Previous research has failed to find a robust and consistent relationship between IT investments and firm performance, which has led IT experts to coin the term "IT paradox." We advance one plausible explanation for the apparent IT paradox that, in hospitals, IT capabilities may not have a direct relationship with quality of patient care. Rather, the relationship may be mediated by other factors.

In a health care setting, encounters of patients with health care professionals and the responsiveness of health care professionals to the needs of patients lie at the core of health care delivery. In this study, we examine the important role of proactive employee behavior and argue that it is an important mediator of the relationships of IT capabilities with quality of patient care in U.S. hospitals. Professional service firms, such as U.S. hospitals, require a more proactive rather than a standard behavior from employees to be able to deliver exceptional service (Korczynski, 2002; McClean & Collins, 2011; Robertson & Swan, 2003). Proactive work behavior consists of initiative and flexibility. Initiative or self-starting behavior implies employees doing something without being told or without an explicit role requirement (Crant, 2000; Frese & Fay, 2001). Flexibility is the capacity of employees to adapt to changing situations (Bhattacharya, Gibson, & Doty, 2005).

Frese and Fay (2001) refer to proactive behavior as an "active performance concept" because, in contrast to traditional performance concept that assumes a given task or goal, it implies that people can go beyond assigned tasks and show required initiative and flexibility in performing their jobs effectively. According to the authors, the proactive behavior is not extra role behavior; employees can engage in all work activities including their formal tasks proactively. Proactive behaviors are now viewed as important in most organizational environments (Beltran-Martin & Roca-Puig, 2013; Martin, Liao, & Campbell, 2013). The notion of proactive work behavior is consistent with the social cognitive theory that assumes humans as reflective, self-regulating agents.

Effective HITs by elevating superior information capability (ability to provide data and information to users with the appropriate level of accuracy, timeliness, reliability, security, and confidentiality) encourage desirable behaviors and values, such as proactiveness, sharing, and integrity, in health care workers (Mithas, Ramasubbu, & Sambamurthy, 2011). Poor HITs, on the other hand, can cause errors and frustrate and distract health care workers from taking care of their patients. The paper system and associated delays can be a source of errors and frustration and may undermine effort put forth by staff involved in care delivery. Hence, the following hypotheses:

Hypothesis 4: The positive relationship of IT infrastructure with quality of patient care is mediated by proactive behavior of health care workers.

Hypothesis 5: The positive relationship of professionalism of IT staff with quality of patient care is mediated by proactive behavior of health care workers.

Methods

Sample and Data Collection

The short-term acute care represents the most common health care delivered by hospitals in the United States. There are

about 5,200 such hospitals that deliver short-term acute care and about 1,280 critical access hospitals. Using a stratified sampling approach, 400 acute care hospitals and 200 critical access hospitals were selected, with 100 acute care and 50 critical access hospitals each from the four geographical regions of the United States: Northeast, Southeast, Midwest, and West.

The data were collected from multiple informants to get as representative and balanced perceptions of HITs in hospitals as possible. The titles of the senior managers representing the hospital administration included chief executive officer (CEO), chief operating officer (COO), chief financial officer (CFO), chief human resource officer (CHRO), and CIO, and the titles of senior managers representing hospital clinicians included chief medical officer (CMO), chief nursing officer (CNO), director of radiology, director of laboratories, and director of rehabilitation. The names and exact titles of the senior managers were collected from the directory of the *American Hospital Association*. On average, the directory listed names of about four senior managers for each hospitals, with titles of managers varying from one hospital to the other somewhat. The directory listed names of 2,205 senior managers of 600 hospitals to whom survey questionnaires with personalized cover letters were sent through the regular mail. In all, 458 completed questionnaires were received with an overall survey response rate of 20.8%.

Although considerable disagreement between the reports of multiple key informants can exist, it was not of chief concern to us because variance in self-reports have been suggested to occur more because of the unique perspectives of the key informants rather than because of their perceptual biases (Kumar, Stern, & Anderson, 1993). Thus, given our preference for capturing diverse and unique perspective rather than achieving consistency in responses across respondents from the same hospital, we analyzed data at the individual respondent level rather than combining scores of managers from the same institution and then analyzing data at the hospital level.

We administered the survey using Dillman et al.'s (2009) total design methodology. A prenotification letter was sent to all the informants indicating that they would receive a questionnaire in about a week's time. This letter was followed by the first wave of the survey that included personalized cover letter, the survey instrument, and the self-addressed postage-paid reply envelope. The respondents were assured of the strict confidentiality of their responses. The survey was followed by a thank-you-cum-reminder card after about 10 days. A second reminder of the survey was mailed to all participants after another 4 weeks. To enhance the response rate, the respondents were also offered a summary of the findings upon completion of the study.

The average number of employees and staffed beds in the surveyed hospitals were 1,568.4 (*SD* = 2,399.4) and 176.4 (*SD* = 201.1), respectively. The average organizational tenure (years in present hospital) and job tenure (years in current position) of respondents were 14.2 years (*SD* = 10.7 years) and 9.4 years (*SD* = 8.2 years), respectively. One hundred and thirty (31%) respondents were from government-owned hospitals, 249 (59%) were from not-for-profit hospitals, 13 (3%) were from investor-owned (for-profit) hospitals, and 29 (7%) belonged to not-for-profit (church-owned) hospitals. Seventy-nine (19%) of the respondents were CEOs of hospitals, 27 (6%) were COOs, 33 (8%) were CFOs, 39 (9%) were CMOs, 80 (19%) were CHROs, 33 (8%) were CIOs, 34 (8%) were CNOs, 32 (8%) were directors of radiology, 33 (8%) were directors of laboratories, and 34 (8%) were directors of rehabilitation. All four regions of the United States were adequately represented with 22% respondents from Northeast, 19% from Southeast, 31% from Midwest, and 28% from the West region.

Measures

This study has two independent variables, type of HIT system and IT capabilities; one mediating variable, proactive employee behavior; and one dependent variable, quality of patient care. The data related to two independent variables and the mediating variable were gathered through the survey questionnaire mailed to the senior executives of the hospitals. The data on the dependent variable were collected from the *Hospital Compare* Web site. Thus, the data for the study came from two different sources. Further description of the measures used in the study is as follows.

Type of HIT system. The survey respondents were asked to describe the EMR system of their hospital, whether it is built and maintained largely internally or built and maintained largely by an external vendor. Eighty-one respondents indicated that their hospital had implemented a homegrown EMR system and 216 respondents noted that their hospital had implemented an outsourced EMR system. In addition, respondents were asked to indicate the total number of employees and the number of IT staff in their hospital.

IT capabilities. Three scales were used to measure IT capabilities: the CIO's IT vision and competence, IT infrastructure, and professionalism of IT staff. The sample items for the CIO's IT vision and competence scale include "The CIO of my hospital has a compelling vision how to use IT to enhance hospital performance" and "The CIO of my hospital has developed a well-understood IT strategy for the hospital." One of the items for the IT infrastructure is "IT infrastructure greatly helps my hospital in identifying and developing key applications of IT for improving business processes rapidly." A sample item for the professionalism of IT staff is "IT people in my hospital possess excellent technical skills." All three scales used a Likert format ranging from 1 to 6 (1 = *strongly disagree* and 6 = *strongly agree*). The scales of IT capabilities are available from authors upon request.

Proactive employee behavior. Proactive employee behavior is the mediating variable in the study. It consists of five items that were adapted from previous studies (Chuang

& Liao, 2010; McClean & Collins, 2011). A sample item is "Our employees go above and beyond the job requirements." The scale used the Likert format ranging from 1 to 6 (1 = *strongly disagree* and 6 = *strongly agree*). The adapted scale is available from authors upon request.

Quality of patient care. Quality of patient care data was collected using the *Hospital Compare* Web site, an online portal that is developed to publicly report credible and user-friendly information about the quality of care delivered in U.S. hospitals. The data provided on this Web site come directly from the patients, and it has to be reported by a sufficiently large number of patients before it is included in the database. Consequently, data on the Web site is very reliable and robust. We collected data for six indicators of quality of patient care. Two sample indicators are (a) percentage of patients who gave their hospital a rating of 9 or 10 on a scale from 0 (*lowest*) to 10 (*highest*) and (b) percentage of patients who reported YES they would definitely recommend the hospital to others. The scale ranged from 1% to 100%. The scale with all six items is available from authors upon request.

Control variables. Respondent's job title (CEO, COO, CFO, CMO, CHRO, CIO, CNO, director of radiology, director of laboratories, and director of rehabilitation center), organization tenure (years in present hospital), job tenure (years in present job), hospital size (number of employees), and type of ownership (government-owned, not-for-profit, investor-owned, and church-owned not-for-profit) were modeled as control variables in the study. Organization tenure, job tenure, and hospital size were measured as continuous variables. Respondent's job title and hospital ownership were modeled as categorical variables using nine and three dummy variables, respectively. Because the quality of overall management may confound the relationships of IT capabilities with quality of patient care, we controlled for the overall quality of hospital management in our analysis as well. We asked survey respondents to indicate the overall quality of management of their hospital using the following statement in the questionnaire: "Please check the percentage you think best estimates how well your hospital is managed as compared to other hospitals in the state over the past three years."

Data Analysis

IT capabilities and proactive employee behavior were measured using the subjective perceptions of the senior executives of hospitals. The quality of patient care as reported by hospital patients was collected from the *Hospital Compare* Web site. The convergent and discriminant validities of the constructs were tested by confirmatory factor analysis using LISREL 8.80. As the data were nonnormally distributed, the analyses were conducted with maximum likelihood and Satorra–Bentler-corrected standard errors (Satorra & Bentler, 1994). Satorra-Bentler's chi-square (SB-χ^2) corrects chi-square values for its upward bias in the case of nonnormally distributed data. To generate SB-χ^2 values, we included the covariance matrix of the indicators and the asymptotic covariance matrix as input of the model. Apart from the SB-χ^2, other measures of fit like the root mean square error of approximation (RMSEA), nonnormed fit index (NNFI), comparative fit index (CFI), and standardized root-mean-square residual (SRMR) were also analyzed.

Results

Validity and Reliability of Constructs

Table 1 presents the confirmatory factor analysis results along with the interconstruct correlations. Overall, the results point to desirable psychometric properties of our measures. In particular, Cronbach's alphas and composite reliability values were well above the suggested minimum value of .70 (Anderson & Gerbing, 1988; Nunnally & Bernstein, 1994).

Next, we examined the discriminant validities of the five latent constructs in the study (*the CIO's IT vision and competence*, *IT infrastructure*, *professionalism of IT staff*, *proactive employee behavior*, and *quality of patient care*) by applying the Fornell and Larcker (1981) test. This test requires average variance extracted (AVE) of each construct to exceed the square of correlations shared between the latent constructs. Table 1 shows that AVE of each construct was greater than .5 and the square root of AVE was greater than the correlations between constructs. Finally, we compared two models where the correlation between the constructs is freely estimated in the first and constrained to unity in the second model (Anderson & Gerbing, 1988). The χ^2-difference test is significant ($\Delta\chi^2[10] = 1{,}729.26$, $p < .001$) and suggests that the correlation between the constructs significantly differs from 1. This indicates the distinctiveness of the latent constructs used in this study. The overall fit measures are reported in Table 1.

Testing of Hypotheses

We used one-way ANOVA to identify differences in *quality of patient care* between health care providers deploying internally developed HIT system and those outsourcing it. The last two columns of Table 2 show the values of the *F*-statistics and their levels of significance. *F*-statistics for quality of patient care was statistically significant. That is, mean quality of patient care in hospitals using internally developed EMRs (mean = 72.48) was significantly higher than hospitals using outsourced EMRs (mean = 70.99). This finding supports Hypothesis 1.

We performed an additional analysis that compared the size of IT departments (the ratio of total number of employees to the number of IT employees) in hospitals with

Table 1

Descriptive statistics and interconstruct correlations (N = 291)

	Variables	Standardized loadings	α[a]	*M*	*SD*	CR[b]	Interconstruct correlations 1	2	3	4	5	6	7	8	9	10
Control variables	1. Ownership	–	–	1.86	0.77	–	–									
	2. Respondent															
	3. Job tenure	–	–	4.99	2.88	–	−.06	–								
	4. Organizational	–	–	9.43	8.16	–	.01	.14*	–							
	tenure	–	–	14.20	10.70	–	.01	.06	.53**	–						
	5. Number of	–	–	1,568.41	2,399	–	.06	.02	−.13*	−.08	–					
	employees															
Latent variables	6. Vision and competence of chief information officer	.54–.83	.93	4.56	0.97	.89	−.07	−.09	.07	.07	.08	(.75)				
	7. Information technology (IT) infrastructure	.82–.93	.93	4.47	1.05	.93	−.02	−.04	.10	.14*	.02	.58**	(.88)			
	8. Professionalism of IT staff	.66–.87	.91	4.66	0.94	.88	−.04	.04	.14**	.09	−.08	.64**	.65**	(.78)		
	9. Proactive employee behaviors	.77–.88	.92	4.80	0.78	.92	−.01	.01	.15**	.16**	−.04	.45**	.42**	.57**	(.83)	
	10. Quality of patient care (Hospital Compare Web site)	.57–.96	.90	67.32	6.33	.90	−.22**	.08	.04	.01	−.26**	.03	.03	.07	.21**	(.79)

Hypothesized model fit: SB-χ^2[326] = 441.59, $p < .01$; RMSEA = .04; NNFI = .98; CFI = .99; SRMR = .05.
Model with interconstruct correlations as 1: SB-χ^2[336] = 2,170.85, $p < .01$; RMSEA = .14; NNFI = .86; CFI = .87; SRMR = .15.

Note. Square root of average variance extracted provided in parentheses along the diagonal of interconstruct correlations.

[a]α = Cronbach's alpha reliability.

[b]CR = composite reliability of the construct measures.

*$p < .05$ (two-tailed).

**$p < .01$ (two-tailed). $N = 291$.

home-grown HIT systems and hospitals deploying an outsourced HIT system. Hospitals having an in-house system on average employed one IT employee for every 73.3 hospital employees as compared to one IT employee for every 80.3 hospital employees in hospitals using an outsourced HIT system (see Table 2). The difference in the size of the IT departments in two sets of hospitals was statistically insignificant. Hospitals showed a high degree of variation in the size of their IT departments as revealed by high standard deviations.

To test the relationships between constructs, we employed the structural model using the maximum likelihood estimation procedure. The structural model had the same indicator structure as the measurement model but included direct paths from *the CIO's IT vision and competence*, *IT infrastructure*, and *professionalism of IT*

Table 2

One-way ANOVA results for quality of patient care and size of information technology department

Dependent variable	Mean values: EMRs[a] in-house	EMRs outsourced	*F*	Sig.
Quality of patient care	72.48 ($n = 81$; $SD = 5.05$)	70.99 ($n = 216$; $SD = 5.73$)	4.24	.04
Size of information technology department	73.30 ($n = 97$; $SD = 50.30$)	80.27 ($n = 293$; $SD = 68.48$)	0.85	.35

Note. EMRs = electronic medical records.

staff to *proactive employee behavior* and to *quality of patient care*. The direct paths from *the CIO's IT vision and competence* to *proactive employee behavior*, from *IT infrastructure* to *proactive employee behavior*, from *the CIO's IT vision and competence* to *quality of patient care*, from *IT infrastructure* to *quality of patient care*, and from *professionalism of IT staff* to *quality of patient care* were nonsignificant and dropped. Paths from control variables that were nonsignificant were also dropped. The pruned model was reestimated and produced a very good fit with the data (SB-χ^2[536] = 762.17, $p < .01$; RMSEA = .04; NNFI = .99; CFI = .99; SRMR = .05). Figure 2 depicts the best fitting structural model. Overall, the model explained 65% of the variance in *IT infrastructure*, 68% of the variance in *professionalism of IT staff*, 38% of the variance in *proactive employee behavior*, and 31% of the variance in *quality of patient care*. For clarity of presentation, the model in Figure 2 shows relationships between main constructs only and does not include detailed structural model with indicators of latent constructs. The structural model with all the details can be had from the authors.

Hospital size (number of employees) and *ownership of hospitals* were significantly related to *quality of patient care*. *Hospital size* was negatively related to *quality of patient care* ($\beta = -.37$, $p < .01$). Government-owned hospitals were the best performing hospitals when it comes to quality of patient care. Not-for-profit hospitals, investor-owned hospitals, and church-owned hospitals were lower in patient care than government hospitals (βs = −.19, $p < .01$; −.25, $p < .01$; and −.26, $p < .01$, respectively).

The CIO's IT competence and vision was highly significantly related to both *IT infrastructure* ($\beta = .89$, $p < .01$) and *professionalism of IT staff* ($\beta = .95$, $p < .01$), thus providing support to Hypotheses 2 and 3.

The relationship of *Professionalism of IT staff* with quality of patient care was found to be mediated by *proactive employee behavior*, thus lending support to Hypothesis 5. Hypothesis 4, that is, the positive relationship of IT infrastructure with quality of patient care is mediated by proactive employee behavior, was not supported as there was no significant path from IT infrastructure to proactive employee behavior.

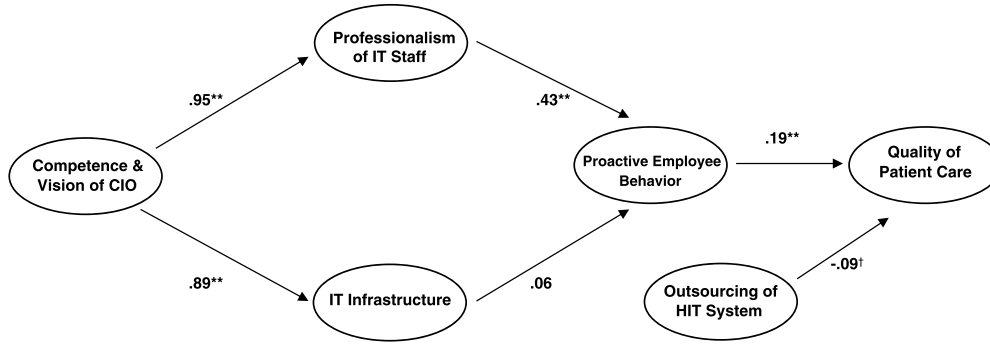
As can be seen from Figure 2, the outsourcing of HITs was negatively (but modestly) related to *quality of patient care* ($\beta = -.09$, $t = -1.62$, $p < .10$). The finding shows that the *quality of patient care* is lower for hospitals where the HITs are outsourced than hospitals where HITs are maintained in-house. The finding further support our observation in Table 2 and Hypothesis 1, which states that the *quality of patient care* is significantly higher in hospitals that have built an in-house IT system than those that have relied upon an outsourced HIT system.

Discussion

In this study, we examined the relative effectiveness of homegrown and outsourced HIT systems in a national sample of U.S. hospitals. Effectiveness of HIT systems is determined through their impact on quality of patient care being provided in hospitals. An effective HIT system will have a

Figure 2

The mediated structural model with standardized path coefficients (N = 291)



Note. IT = information technology; CIO = chief information officer; HIT = health information technology. Indicators of latent variables, nonsignificant paths, and paths from control variables are not shown for the ease of presentation. Structural model fit: SB-χ^2[536] = 762.17, $p < .01$; RMSEA = .04; NNFI = .99; CFI = .99; SRMR = .05. $N = 291$.

*$p < .05$.

**$p < .01$.

†$p < .10$.

positive relationship with quality of patient care, whereas an ineffective HIT system will have weak to no relationship with quality of care provided in a hospital. The results suggest that the quality of patient care is significantly higher in hospitals deploying homegrown HIT systems than hospitals deploying outsourced HIT systems. This finding is consistent with the findings of the systematic review of 257 studies on the impact of HITs on quality, efficiency, and costs of medical care conducted by Chaudhry et al. (2006). These authors had noted that a disproportionate number of studies on the realized benefits of IT were from a small set of early adopter institutions that had implemented homegrown HIT systems. This occurred because HIT systems require a lot of patience and need to be implemented over a long period of time in a gradual, iterative fashion.

This study revealed another interesting finding, namely, the size of IT department (the ratio of total number of employees to the number of IT employees) in hospitals with homegrown HIT systems was not statistically different from the size of IT department in hospitals outsourcing their HIT system. This finding may have major cost implications in that one would expect a hospital deploying an outsourced HIT system to require a smaller IT department as compared to a homegrown HIT system, because most aspects of an outsourced HIT system are likely to be managed by the vendor. HIT vendors may charge a high annual consultancy fees for building and maintaining a HIT system. Despite paying the annual consultancy fees, it seems that hospitals still needed to maintain a large IT staff of their own to interface with the external vendor.

The three basic dimensions of IT capabilities identified in this study were found to have no direct relationship with quality of patient care, which is consistent with prior research showing a weak or nonexistent direct relationship between IT investments and organizational outcomes. This study provides a nuanced support for the positive relationship of IT capabilities with quality of patient care in which the CIO's IT vision and competence drives the professionalism of IT staff that, in turn, boosts proactive employee behavior. Proactive employee behavior then leads to higher quality of patient care. Thus, this study contributes to the existing knowledge by highlighting the role of three important but less explored concepts—the CIO's IT competence and vision, professionalism of IT staff, and proactive employee behavior. The crucial role of professional competence/vision of the CIO is corroborated by a statement made by one of the respondents in the survey to an open-ended question. The respondent noted: "Approximately 2 years ago we hired a CIO with virtually no health care IT experience. Since that time we have spent thousands of dollars bringing in consultants to help him do his job at the detriment of IT staff morale as well as other staff's morale. As they see dollars fly out of the door needlessly."

The second critical but less investigated concept is that of proactive employee behavior, which plays a pivotal role in the relationship between IT capabilities and quality of patient care. Absent proactive employee behavior, there are no paths from IT capabilities to quality of patient care. Thus, the crucial role of the CIO and proactive employee behavior in the effective implementation of an HIT system seems a fruitful and fertile area for future research. The implication for practice is that health care providers need to identify a professionally competent CIO who has a compelling vision of IT in health care delivery process. Without such leadership, the implementation of HITs is not likely to succeed. Furthermore, health care providers need to develop IT professionals that can support health care workers in providing exemplary patient care.

Strengths and Limitations of the Study

The strength of the study is that we used a national sample of hospitals and utilized a variety of informants representing both business and clinical sides of hospitals. The number of completed questionnaires (N = 458) was quite adequate. However, because of the lack of quality of patient care data reported by patients at the Hospital Compare Web site, the number of cases available for analysis got reduced to 291.

Although we received adequate number of responses across titles of senior executives, some titles were represented more than others. Similarly, responses from hospitals from Midwest and West were somewhat higher than responses from hospitals in the Northeast and Southeast.

Although the response rate at individual respondent level is on the lower side (20.8%), 314 of a total of 600 hospitals (response rate, 52.3%) were represented in our data. Anseel, Lievens, and Schollaert (2010), in their meta-analytical review of response rates in organizational science, concluded that the higher respondents are situated in the organizational hierarchy, the harder it is to persuade them to respond to the survey. These authors also reported a decline in response rate in surveys over time.

Another strength of the study is that the data on the dependent variable, quality of patient care, were collected from an independent source, namely, the reports of hospital patients compiled and maintained at the Hospital Compare Web site. Thus, the study does not have common method bias often found in survey research.

The study was cross-sectional in nature, and thus, inferences about causality are limited. Future studies should test the relationships between IT capabilities, proactive work behavior, and quality of patient care using other study designs in order to better understand the impact of IT capabilities on quality of patient care. The small sample size may also be one of the reasons contributing to the surprising findings of the study: (a) the high use of homegrown EHRs and (b) the higher quality of patient care in public hospitals. Future studies should verify the findings using a larger sample of health care organizations.

In this study, we sampled senior managers of hospitals with diverse titles representing both administrative and

clinical sides. The objective was to get a wide range of perspectives. However, doing so might have resulted in unreliability and inaccuracy of their responses because many of these senior managers were providing information on IT capabilities, the issues outside their area of expertise. Similarly, individual respondent's rating of proactive work behaviors may be based more on the perception of their individual units and less representative of the organization as a whole. The resulting error or noise in measurement if any might have reduced the effect sizes reported in this study. Having said so, given that the survey respondents were senior executives and very busy individuals, we do not think they would complete the survey if they were not sure of their responses to the survey items. However, the response rate of the survey might have been the casualty in cases where senior managers wanted to participate in the survey but did not because they were not certain of their responses.

Conclusion

HITs are advanced, complex, permeate the entire health care delivery process, and have a great potential to improve quality and reduce cost of health care. Thus, their implementation needs to be taken seriously and not rushed. The study findings suggest that health care providers may be better off by implementing a home-grown HIT system, which they seem reluctant to do. Their reluctance may partly be because of their lack of IT expertise. In their quest for a quick solution and a foreseeable difficulty in building a home-grown HIT system, health care providers seek out HIT vendors, and this is where things get complicated and go wrong in a hurry. Without sufficient in-house IT capabilities, it is difficult for a health care provider to figure out which HIT system, out of a hundred or more available in the market, may better suit its needs and be more affordable. Furthermore, because of lack of IT expertise, most health care providers also fail to anticipate fully the implementation problems and cost over runs, the difficulties they want to avoid in the first place by outsourcing their HIT system. The study findings advocate the crucial role of the CIO in the implementation of HITs. A CIO has to have an excellent IT expertise, a compelling vision of IT, leadership skills, and business acumen. IT professionals, the other key dimension of IT capabilities, should focus on how to foster proactive behavior in heath care workers in delivering high quality of patient care.

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