The Relationship Between Local Hospital IT Capabilities and Physician EMR Adoption

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Abstract:
In light of new federal policies allowing hospitals to subsidize the cost of information systems for physicians, we examine the relationship between local hospital investments in information technology (IT) and physician EMR adoption. Data from two Florida surveys were combined with secondary data from the State of Florida and the Area Resource File (ARF). Hierarchal logistic regression was used to examine the effect of hospital adoption of clinical information systems on physician adoption of EMR systems after controlling for confounders. In multivariate analysis, each additional clinical IT application adopted by a local hospital was associated with an 8% increase in the odds of EMR adoption by physicians practicing in that county. Given this existing relationship between hospital IT capabilities and physician adoption patterns, federal policies designed to encourage this more directly will positively promote the proliferation of EMR systems.
Keywords: Physician EMR adoption, Hospital information systems, Stark law

Article:

Introduction

One major policy goal of the U.S. Department of Health & Human Services (DHHS) is to make the use of electronic medical records (EMR) universal among ambulatory physicians' practices [1]. However, the cost of such systems can be prohibitively high for smaller medical groups [2]. One possible means to overcome this barrier is to have medical practices linked into larger health systems' EMR systems [3-5]. However, federal laws and regulations were generally interpreted as prohibiting this type of sharing. Therefore, DHHS modified its existing policies and rules to permit hospitals and certain other organizations to donate EMR technology and supporting services to physicians without violating either the physician self-referral statute (Stark Law) or anti-kickback law [6]. Both changes are a result of the Congressional mandate in the Medicare Prescription Drug, Improvement, and Modernization Act of 2003 to create safe harbor exemptions that enable hospitals to promote local physicians' adoption of EMR technology.

Despite the potential to obtain EMR technologies at greatly reduced costs, many physicians perceive such an arrangement with a particular hospital as ceding a significant amount of professional autonomy to another organization [7]. Moreover, many physicians may be unclear about data ownership issues arising when they linking their practice's medical records with that of the hospitals. On the other hand, it is uncertain how many hospitals will take advantage of the new policies. Doing so would represent a significant new expense and potential liability exposure without any discreet return on investment [8]. Despite the potential implications of the DHHS' new policies, no previous study has examined how investments by hospitals in their own IT capabilities influence the adoption of EMR systems by physicians practicing nearby. Understanding the existing relationship between hospitals and physicians with respect to IT transfer is an important first assessment in order to forecast the potential impact of the DHHS policy shift.

The purpose of this study is to explore the relationship between physicians' EMR adoption and local hospitals' IT capabilities. There are several theoretical reasons, described below, how the EMR adoption decisions among physicians might be related to their local hospitals' IT capabilities. By leveraging two unique datasets collected in Florida, we are able to examine this relationship and examine how the clinical IT capabilities of hospitals

may impact the subsequent EMR adoption patterns of local physicians prior to the federal rule changes in 2006. Because our data was collected prior to the DHHS policy changes, direct questions about hospital donation of IT systems to physicians were not asked because this practice was previously not permitted.

The results of our study will aid policymakers in understanding the potential impacts of the DHHS policy. In particular, assessments of individual market's potential to share EMR technology between hospitals and physicians can be made. Further, other market factors (e.g., managed care penetration) that may influence EMR transfer are explored.

Background

Economies of scale have allowed hospitals [9] to adopt expensive technologies, such as information systems, earlier than physicians in private practices. A recent report found that approximately three quarters of U.S. hospitals have either fully or partially implemented laboratory and radiology information systems that allow for results review and electronic order entry [10]. Comparatively, EMR adoption among physicians is estimated to be 17–25% as of 2006 [11].

The idea that certain market characteristics can influence quality of care related technology adoption is common in the healthcare literature [12]. Several reasons exist to suggest why physicians' EMR adoption decisions are influenced by their local hospitals' IT capabilities. First, a significant benefit of adopting an EMR system is the ability to coordinate care more effectively. Community-based physicians report a high level of dissatisfaction with hospital-based physicians' communication of critical information upon discharge of their shared patients [13]. The potential to access discharge summaries including complete diagnostic test results, treatment courses, medications prescribed, and follow-up plans would greatly improve the coordination of care in many communities [14, 15]. Thus, hospitals with robust IT capabilities may indirectly entice physicians in their areas to adopt EMR systems.

A second reason doctors may desire EMR systems arises during their medical training. Physicians who receive training in hospitals with sophisticated IT applications are likely to experience first hand the benefits of using such systems. Under such circumstances, more recently trained physicians may have become reliant on clinical IT systems for their standard patient care processes. Overall, we hypothesize that in a given market, hospitals' IT capabilities will be positively correlated with physicians' EMR adoption rates. Specifically, we would expect physicians with private practices in areas where hospitals have relatively robust IT capabilities, vis-à-vis other markets, to be more likely to adopt EMR systems.

Methods

A survey targeting all hospital chief information officers (CIOs) in Florida (n=198) was fielded in 2003 to collect data about hospital IT capabilities. Specifically, the survey captured detailed information about the current adoption of various clinical and non-clinical information systems among hospitals in the state. The overall response rate to the hospital IT survey was 49.5% and respondents did not differ from non-respondents with respect to bed-size, system affiliation, or tax status. Separately, a 2005 comprehensive Florida-based survey assessed EMR and other IT adoption among physicians in private ambulatory practice (sample n= 14,92 1). The physician survey achieved a 28.2% participation rate and no meaningful response biases were identified in either sample [16]. A more detailed description of the methods and results of these Florida-based studies has been previously published [5, 17– 21]. Both data collection efforts were approved by the Florida State University's Institutional Review Board.

In the current study, the dependent variable of interest was EMR adoption among physicians. The key independent variable was the average number of clinical IT systems adopted by hospitals in the physicians' market area. The data was analyzed using a multi-level logistic regression model that controlled for market characteristics (level 1) and physician practice characteristics (level 2). The following is a description of the statistical methods including the primary and secondary data utilized in the analysis.

Market level data

In our analyses, the market level represented the county in which physicians practice. The independent variable was the average number of clinical information systems adopted among hospitals in the county. This measure is based on a previously validated method of measuring clinical IT hospital capabilities [22]. To assure that an exhaustive list of critical IT applications was captured by the survey, we conducted an extensive literature review, had the instrument's face validity established by an expert panel, and solicited input from professional societies when generating the list of potentially available clinical systems. The list of 25 clinical systems assessed in the survey is presented in the Appendix.

To operationalize the measure of clinical hospital IT capabilities, we used data from the hospital IT survey in which CIOs were asked to indicate, from a list of 25 clinical information systems, which applications were available at their institution. Each hospital was assigned a score that represented the total number of clinical information systems (out of 25) that were installed at their facility. In our analyses, if more than one hospital was present in a county, we used the average hospital score within that county.

Control variables in the market level component of the analyses included county-level HMO penetration data obtained from the Florida Agency for Health Care Administration, four variables extracted from the Area Resource File (ARF), and a binary measure to represent rural counties as designated by Florida statute. From the ARF, control variables were selected to account for variation in market conditions that may affect hospital and/or physician adoption of IT. Specifically, we controlled for physician competition as measured by physicians per capita, and the percent of residents in the county that were below the poverty line, were white, and were newborns.

Physician practice level data

To control for physician practice characteristics, we extracted several variables from the physician survey of EMR use. Specifically, we included variables in the model that accounted for practice-type (primary care vs. other), practice size, payer-mix, and physician age as measured by years in practice since graduating from medical school. Additionally, we controlled for the self-perceived level of computer savvy among each physician because this variable can influence EMR adoption.

Primary care physicians included general practitioners, family physicians, general internists, and pediatricians. Practice size was categorized into four categories representing solo practitioners, those in small practices (two to nine physicians), medium practices (10-49 physicians), and large practices (greater than 50 physicians). Previous work has found that physician payer-mix can influence resource availability and EMR adoption [21, 23]. Therefore, we included measures of the percent of patients in each practice that were covered by Medicare, Medicaid, or private insurance as control variables.

Post-hoc analysis

The hierarchical logistic regression model that was utilized to analyze the data had a cross-sectional design that is not suited to detect causality. Despite controlling for market and practice characteristics that may influence physician adoption of EMR systems, we recognized that some unmeasured market variable had the potential to influence both hospital and physician adoption of IT. To account for this, and to take advantage of the inter-temporal nature of our data, we conducted a post-hoc temporal optimization analysis. Our main model used 2003 hospital IT data and 2005 physician EMR adoption data. Importantly, our physician data also captured the year in which EMR was implemented. Thus, physician adoption in our dataset can be modeled over time. Methodological experts [24] have described the advantages of "inter-temporal optimization" in econometric modeling when longitudinal data is not available for policy-making.

To conduct our post-hoc analysis, we recalibrated our dependent variable (physician EMR adoption) to only include respondents that implemented EMR as of the beginning of 2003. In other words, EMR adopters in 2003, 2004, and 2005 were reclassified as non-adopters for the post-hoc analysis. In the main analysis, we were examining the relationship between 2003 hospital IT adoption and 2005 physician EMR adoption. In the post-

hoc analysis, we were examining how 2003 hospital IT adoption is related to 2003 physician EMR adoption. If the results of both models do not differ, one would be concerned that an unobserved variable may be influencing (and thus associated with) both hospital and physician adoption at the county level. However, if the main model has significant results, but the post-hoc analysis does not, this would suggest that an unobserved variable is not confounding the results and that there may be a temporal (although not necessarily causal) relationship between hospital IT adoption and physician EMR adoption.

Table 1 Descriptive characteristics of variables and their sources

Variables	Market characteristics (county level)		Practice level characteristics	
	Mean (range)	Data source	Frequency (%)	Data source
Avg. number of clinical IT systems adopted at local hospital(s)	12.71 (1–20)	Hospital IT Survey		
Physicians per capita	2.53 (0.07–7.72)	ARF 2004		
Poverty rate	12.9 (7.4–21.8)	ARF 2004		
Managed care penetration rate (%)	21.7 (0–46.1)	Florida AHCA		
Percent of population that is White	77.6 (38.7–95.0)	ARF 2004		
Newborns as percent of population	0.012 (.007–.016)	ARF 2004		
Geographic location		Practice address[a]		
Urban	3950 (94.2%)			
Rural	245 (5.8%)			
Practice size				Physician IT survey
Solo practice			1,228 (30.9)	
2–9 physicians			2,150 (54.2)	
10–49 physicians			385 (9.7)	
50 or greater physicians			206 (5.2)	
Primary care				Physician IT survey
Yes			2,141 (51.8)	
No			1,995 (48.2)	
Years since graduating medical school			21.3 (<1–65)	Physician IT survey
Medicaid practice composition				Physician IT survey
No Medicaid patients (bottom quartile)			1,332 (35.4)	
Typical volume (mid quartiles)			1,337 (36.6)	
High volume (top quartile)			1,052 (28.0)	
Medicare practice composition				Physician IT survey
Low volume (bottom quartile)			1,686 (44.4)	
Typical volume (mid quartiles)			1,249 (32.9)	
High volume (top quartile)			861 (22.7)	
Private insurance practice composition				Physician IT survey
Low volume (bottom quartile)			775 (20.4)	
Typical volume (mid quartiles)			1,893 (49.9)	
High volume (top quartile)			1,126 (29.7)	
Physician self-perceived computer ability				Physician IT survey
Sophisticated computer user			1,845 (45)	
Neutral			1,504 (36.7)	
Unsophisticated computer user			751 (18.3)	

Note: Where appropriate, numbers may not add up to 100% due to rounding. Response rate by question varies slightly.
ARF Area resource file, *AHCA* Agency for Health Care Administration in Florida
[a] Practice address obtained from the Florida Department of Health list of licensed physicians.

Results

Overall, 4,203 respondents completed the physician IT survey and could be matched by practice address to the ARF data and hospital IT data. Descriptive information on each of the variables used in the analysis, including their source, appears in Table 1.

Physician respondents were largely male (75.9%) and worked in either solo (30.9%) or small practices (54.2%). Approximately half were practicing in primary care settings (51.8%). At the county level, the average hospital adopted 12.7 clinical IT applications (out of 25) with a range of one to 20 applications. On average, there were 2.5 physicians per 1,000 residents in each county, and the mean managed care penetration rate was 21.7%. Lastly, 245 (5.8%) physicians were located in a rural area.

A total of 995 (23.7%) physicians indicated using an EMR system at the time of the survey. In multivariate analysis, several market-level and physician-level characteristics were associated with EMR adoption (see Table 2). The average number of clinical IT applications adopted in local hospitals was positively and significantly related to EMR adoption among physicians. In multivariate analysis, each additional clinical IT application adopted by a local hospital was associated with an 8% increase in the odds of EMR adoption by physicians practicing in the county (OR=1.08; 95% CI 1.04–1.12). Additionally, market-level managed-care penetration and newborns as a percent of the population were negatively related to EMR adoption. With respect to managed-care penetration, each 1% increase in the number of county residents using this insurance mechanism was associated with a 2% decrease in the odds of EMR adoption among physicians (OR=0.98; 95% CI 0.96–0.99).

Table 2 Adoption of electronic medical record systems by physicians in Florida (n=4,302)

	Physician EMR adoption	
	Percent	Odds ratio
Market characteristics (county level)		
Avg. number of clinical IT systems adopted at local hospital(s)[a]		1.08**
Physicians per capita[a]		1.07
Poverty rate[a]		1.02
Managed care penetration rate[a] (%)		0.98*
Percent of population that is White[a]		0.19
Newborns as percent of population[a]		0.17**
Geographic location		
Urban	24.1	1.00
Rural	17.6	0.97
Physician level characteristics		
Practice size		
Solo practice	13.8	1.00
2–9 physicians	20.4	1.36*
10–49 physicians	45.2	4.80**
50 or greater physicians	72.8	14.00**
Primary care[b]		
Yes	22.4	1.00
No	25.2	1.14
Years since graduating medical school[a]		0.98**
Medicaid practice composition		
No Medicaid patients (bottom quartile)	24.3	1.00
Typical volume (middle quartiles)	22.1	0.70**
High volume (top quartile)	20.2	0.74*
Medicare practice composition		
Low volume (bottom quartile)	18.7	1.00
Typical volume (middle quartiles)	24.7	1.26
High volume (top quartile)	25.9	1.52*
Private insurance practice composition		
Low volume (bottom quartile)	18.1	1.00
Typical volume (middle quartiles)	25.7	1.57**
High volume (top quartile)	19.6	1.39
Physician self-perceived computer ability		
Sophisticated computer user	34.3	1.00
Neutral	17.5	0.38**
Unsophisticated computer user	10.9	0.25**

*$p<0.05$
**$p<0.01$
[a] Measured on a continuous scale
[b] Primary care includes family physicians, general internists, general pediatricians, and general practitioners

At the physician-level, practice size, age, and payer-mix were related to EMR adoption. The findings of these control variables were consistent with previous literature in that larger practices, younger physicians, and those with less reliance on Medicaid were more likely to adopt EMR systems [4, 21, 25, 26]. Additionally, physicians self identifying as 'sophisticated computer users' were significantly more likely than those identifying as 'neutral' or 'unsophisticated' to adopt EMR systems. Thus, the inclusion of this variable in the model further controls for the natural tendencies among sophisticated computer users to more likely adopt EMR systems. The results of our post-hoc analysis, which was conducted to address the cross-sectional nature of our data, found that the relationship between hospital IT capabilities and physician EMR adoption has a temporal characteristic that is not simply cross-sectional. When we re-ran our primary analysis with the substituted outcome variable, the relationship between hospital IT capabilities and physician adoption decreased in magnitude (adjusted odds ratio became 1.01) and became non-significant. This suggests that the hospital IT variable, in our main analysis, may be influencing EMR adoption among physicians and not some unobserved external variable influencing both hospital and physician IT adoption. All other variables in the post-hoc analysis maintained their magnitude, and significance.

Discussion

The DHHS decision, and a subsequent Internal Revenue Service's memo upholding the decision, to allow hospitals to subsidize the cost of physician EMR systems promises to help accelerate the lagging EMR adoption curve among physicians [6]. In assessing the potential future impact of this policy, it is important to understand the existing relationship between hospital IT capabilities and local physician adoption of EMR systems. This paper leveraged two previously collected IT datasets to examine this important relationship.

A key finding of our Florida county-based analysis is that IT investments by hospitals in 2003 were associated with physician adoption of EMR systems in 2005. Specifically, physicians in markets where hospitals had more robust clinical IT capabilities were significantly more likely to adopt EMR systems even after controlling for other market and physician characteristics that influence adoption. This finding provides an important historical context in which to understand the future impact of the DHHS policy change and provides a baseline set of estimates to compare against future trends.

Previous research has demonstrated that physician EMR adoption is not easily promoted with national policy statements that lack tangible benefits to doctors [2]. The DHHS policy decision, however, will likely have the desired effect because promoting hospital sharing leverages the existing positive correlation between increased hospital IT capabilities and increased physician EMR use in the same market. Given an existing relationship of hospital IT capabilities and physician adoption patterns, any policy changes designed to encourage this more directly will positively promote the proliferation of EMR systems. Future analyses designed to measure the impact of the DHHS policy should consider the historic influence of hospitals on physicians when determining the true impact of the policy on IT adoption. Additionally, future studies should consider both mimetic and normative institutional forces that may contribute to IT and EMR adoption.

Despite the new findings that our analysis provides, several limitations are worth mentioning. First, although robust, our data is derived from a single state and generalizations to other U.S. locations must be done with caution. Second, all studies relying on survey data are based on ability and desire of respondents to provide accurate answers. Third, despite adequate response rates, and an analysis that failed to detect response bias, we recognize the potential for such bias to exist. Also, we did not have access to hospital data that would allow us to determine the percent of beds in each county that were represented by hospitals in our analysis. Lastly, although we were able to infer that a temporal relationship between our variables may exist, our method falls short of a true longitudinal approach that can determine causality.

EMR adoption among physicians is a multifaceted and complex phenomenon. Countless factors likely influence the decision to adopt among physicians. Policy-makers must first understand the factors associated with EMR adoption. Our study contributes an important new look at how local hospital IT capabilities are associated with physician EMR decisions. Given the national debate around changes to the Stark regulations, understanding this

relationship is paramount. Whether this policy change will, in and of itself, result in a detectable acceleration of the physician adoption curve will likely require future longitudinal studies.

Appendix

Table 3 Clinical information technologies potentially available in hospitals

1) Computerized physician order entry
2) Electronic medical record
3) Pharmacy information system
4) Pharmacy dispensing
5) Radiology information system
6) Laboratory information system
7) Medical record imaging
8) Transcription
9) Nurse charting or care planning
10) Bar-coded medical management
11) Clinical decision support system
12) Clinical data repository
13) Clinical resource scheduling
14) Chart tracking and locator
15) Chart deficiency
16) Picture archiving and communication systems
17) Bioterrorism disease surveillance system
18) Abstracting
19) Critical care bedside
20) Telemedicine system
21) Emergency department medical system
22) Medical/surgical bedside terminals
23) Operating room system
24) Order communication results
25) Scanning clinical documents

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