Characteristics of Hospitals Associated with Complete and Partial Implementation of Electronic Health Records

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Abstract

Objectives: (1) To determine the proportion of hospitals with and without implementation of electronic health records (EHRs). (2) To examine characteristics of hospitals that report implementation of EHRs partially or completely versus those that report no implementation. (3) To identify hospital characteristics associated with nonimplementation to help devise future policy initiatives.

Methods: This was a retrospective cross-sectional study using the 2012 American Hospital Association Annual Survey Database. The outcome variable was the implementation of EHRs completely or partially. Independent variables were hospital characteristics, such as staffing, organization structure, accreditations, ownership, and services and facilities provided at the hospitals. Descriptive frequencies were determined, and multinomial logistic regression was used to determine variables independently associated with complete or partial implementation of EHRs.

Results: In this study, 12.6 percent of hospitals reported no implementation of EHRs, while 43.9 percent of hospitals implemented EHRs partially and 43.5 percent implemented EHRs completely. Overall characteristics of hospitals with complete and partial implementation were similar. The multinomial regression model revealed a positive association between the number of licensed beds and complete implementation of EHRs. A positive association was found between children's general medical, surgical, and heart hospitals and complete implementation of EHRs. Conversely, psychiatric and rehabilitation hospitals, limited service hospitals, hospitals participating in a network, service hospitals, government nonfederal hospitals, and nongovernment not-for-profit hospitals showed less likelihood of complete implementation of EHRs.

Conclusion: Study findings suggest a disparity of EHR implementation between larger, for-profit hospitals and smaller, not-for-profit hospitals. Low rates of implementation were observed with psychiatric and rehabilitation hospitals. EHR policy initiatives need to target smaller institutions in particular to bridge this possible gap.

Keywords: electronic health records, EHRs, implementation, services, characteristics

Introduction

Since 2009, the federal government has increased efforts to promote the use of information technology in healthcare settings and increase the adoption and implementation of electronic health records (EHRs). One of the initiatives is the Health Information Technology for Economic and Clinical Health (HITECH) Act, part of the American Recovery and Reinvestment Act. The HITECH Act mandated that all public and private healthcare providers and other eligible clinical professionals adopt and demonstrate meaningful use of EHRs in order to maintain their existing Medicaid and Medicare reimbursement levels. It also included financial incentives worth $30 billion for healthcare providers that demonstrated meaningful use of EHRs.[1]

Meaningful use is defined by the use of certified EHR technology in a manner that provides for the electronic exchange of health information to improve the quality of care, and when using certified EHR technology, the provider must submit to the Department of Health and Human Services (HHS) information on quality of care and other measures.[2,3] Meaningful use is divided into three stages.[4] Stage 1 meaningful use criteria focus on electronically capturing health information in a structured format and using that information to track key clinical conditions. In addition, stage 1 involves communicating that information for care coordination purposes, implementing clinical decision support tools to facilitate disease and medication management, and reporting clinical quality measures and public health information. Stage 2 meaningful use criteria expand upon the stage 1

criteria to encourage the use of health information technology for continuous quality improvement at the point of care and the exchange of information in the most structured format possible. The goal of stage 3 is to promote improvements in quality, safety, and efficiency leading to improved health outcomes, focusing on decision support for national high-priority conditions, patient access to self-management tools, comprehensive patient data, efforts to improve population health, and robust, patient-centered health information exchange.[5]

Another government initiative that encouraged EHR implementation was the Affordable Care Act (ACA). It came into effect in 2010, and EHR implementation was mandated for the end of 2014. The ACA also established that failure to participate in EHR implementation by 2015 would result in the reduction of Medicare and Medicaid reimbursement to the noncomplying medical providers and that penalties would rise annually thereafter.[6,7] Eventually, EHR compliance is expected to achieve better clinical outcomes, improved population health outcomes, increased transparency and efficiency, empowerment of individuals, and more robust data for research on health systems.[8]

Overall, these government initiatives have been successful in fomenting and influencing steady growth in the adoption of health information technology in healthcare practices. Adoption and use of EHR systems has increased more than five-fold since 2008.[9] According to HHS, more than 50 percent of eligible professionals demonstrated basic implementation of EHRs, while more than 80 percent of hospitals demonstrated meaningful use of EHRs in early 2014—a drastic increase since 2008.[10,11] Studies have reported on the growth and proportion of hospitals adopting EHRs.[12] However, limited insight is available about the characteristics of the compliant hospitals that have implemented EHRs partially or completely, compared with the characteristics of those that have not. This study aims to provide more insight into this question. Thus the objectives of the study are to (1) examine the annual American Hospital Association (AHA) 2012 database to determine the proportion of hospitals that have adopted EHRs completely and partially; (2) compare and contrast characteristics of hospitals compliant with partial or complete EHR implementation with those that are noncompliant; and (3) identify hospital characteristics associated with nonimplementation to devise future policy directives.

Methods

The study followed an observational retrospective research design using the AHA Annual Survey Database of 2012. The purpose of the AHA survey is to collect utilization, financial, and personnel information on each of the nation's hospitals. The data are from a nationally representative cross-sectional survey of 6,500 hospitals and more than 400 systems in the United States and territories. The database features approximately 1,000 fields covering variables such as hospital organizational structure, personnel, hospital facilities and services, utilization data, managed care contracts, physician arrangements, staffing, and community orientation. The survey is completed by hospitals identified by the AHA, regardless of membership in the AHA.

The outcome variable consisted of the hospital's self-reported level of EHR implementation, categorized into a nominal variable represented as "not implemented," "partially implemented," or "completely implemented." Full or complete implementation refers to implementation of EHRs all "at once across all units of the organization, often referred to as the 'big bang' approach to implementation," whereas partial implementation takes place when "all or parts of the EHR system are gradually implemented across units."[13] The independent variables broadly consisted of hospital attributes such as organizational structure, staffing, and characteristics such as bed size, utilization data, and type of services provided. Organizational structure included managed care arrangements (participation in PPOs and/or HMOs); ownership (for-profit, not-for-profit, government, system); accreditations by the Joint Commission, Healthcare Facilities Accreditation Program (HFAP), and HHS; and critical access hospital status. Staffing consisted of professional staffing in the hospitals (total number of fully employed staff, including physicians, nurses, pharmacists, technicians, and interns). Other independent variables included utilization variables (number of admissions, surgeries, inpatient days, Medicaid and Medicare patient days), number of number of beds or bed size, geographical state, specific healthcare facilities or services provided (screening, radiology, pathology services, etc.), and departments (emergency, neurology, etc.) within the hospitals. Lastly, the type of service was another independent variable in the AHA survey wherein hospitals were broadly categorized according to the type of service they specialized in and provided (general medical and surgical, cancer, heart, etc.).

Statistical analysis consisted of determining descriptive frequencies, constructing contingency tables, and performing bivariate analysis (chi-square testing for categorical variables and simple logistic regression for continuous variables) to compute distributions of hospital attributes by EHR system implementation. A multinomial logit model was then used to compute

maximum likelihood estimates and *p*-values to investigate hospital characteristics significantly associated ($p < .05$) with partial and complete EHR implementation versus no implementation.

Results

This study determined the proportion of hospitals in which EHRs were partially or completely implemented by 2012. Out of a total of 6,307 hospitals, data from 2,157 hospitals (34 percent) were missing. Hence the final sample consisted of 4,150 hospitals. Among the study sample of hospitals, 12.6 percent reported no EHR implementation, 43.9 percent reported partial implementation, and 43.5 percent reported complete implementation. Thus, a total of 87.4 percent of the surveyed hospitals reported at least partial or basic EHR implementation.

Overall, characteristics of hospitals with partial or complete EHR implementation were similar. Hospitals with accreditations from organizations such as the HFAP reported overall higher EHR implementation (see Table 1). Similarly, hospitals participating in a network, HMO, PPO, or group purchasing agreement demonstrated greater EHR adoption. Hospitals in the smallest bed size category ranked the highest in the no implementation category, while those with higher bed size (>500) were the highest in the complete implementation category. No difference was observed in implementation based on the geographical area of the states: smaller states, such as Guam (counted as a state in this survey) (0 percent) and Wyoming (16 percent), had nearly the same low implementation rate as larger states, such as Nevada (23.1 percent) and Alaska (0 percent). High implementation rates were found in large states, such as Minnesota (63.2 percent), Florida (57.5 percent), and Illinois (55.6 percent), and in smaller states, such as Rhode Island (62.5 percent), Vermont (61.5 percent), and Connecticut (62.9 percent).

Table 1: Descriptive Frequencies and Chi-Square Test Association of Hospital Organizational Structure with Electronic Health Record (EHR) Implementation

Organizational Structure (Management and Partnerships of Hospitals)	No Implementation, *n* (%)	Partial Implementation, *n* (%)	Complete Implementation, *n* (%)	$\chi 2$
Accreditation by Healthcare Facilities Accreditation Program (HFAP)	6 (5.1)	55 (46.6)	57 (48.3)	.06
System member	360 (14.1)	1,008 (39.5)	1,187 (46.4)	<.0001*
Contract-managed hospital	70 (14.8)	232 (49.1)	171 (36.2)	.02*
Hospital part of network	407 (16.0)	1,143 (44.8)	999 (39.2)	<.0001*
Hospital part of group purchasing agreement	419 (11.1)	1,696 (44.8)	1,667 (44.1)	<.0001*
Catholic church operated	45 (9.3)	221 (45.6)	219 (45.1)	.06
Critical access hospital	103 (11.1)	492 (52.9)	335 (36.0)	<.0001*
Sole community provider	6 (2.6)	133 (56.6)	96 (40.8)	<.0001*
Formal written contract with an HMO	288 (10.2)	1,237 (43.6)	1,311 (46.2)	<.0001*
Formal written contract with a PPO	323 (10.1)	1,425 (44.9)	1,422 (44.8)	<.0001*
Hospitals that contracted directly with employers or a coalition of employers to provide care on a capitated, predetermined, or shared-risk basis	3 (2.3)	45 (32.6)	82 (63.1)	<.0001*
Community hospital	364	1,708	1,694	<.0001*
Hospital owned in whole or in part by physicians or a physicians' group	50 (24.6)	89 (43.8)	64 (31.5)	<.0001*

* Statistically significant at $p < .05$.

Among specialized service hospitals, general medical and surgical hospitals (47.8 percent) ranked the highest in complete EHR implementation. Higher numbers of hospitals in the psychiatric (52.6 percent), rehabilitation (55.5 percent), and acute long-

term care (48.4 percent) service categories reported no implementation of EHRs in 2012 (see Table 2). Among specific services provided by the hospitals (or their networks within the community or through contractual venture with other providers), those providing services for chronic conditions such as cardiology, oncology, medical surgery, preventive care services such as screening, testing facilities such as ultrasonography, electron beam computerized tomography, and primary care had higher EHR implementation overall.

Table 2: Descriptive Frequencies and Chi-Square Testing of the Association of Type of Service of Hospital with Electronic Health Record (EHR) Implementation

Type of Hospital by Service	No Implementation, *n* (%)	Partial Implementation, *n* (%)	Complete Implementation, *n* (%)	$\chi 2$
General medical and surgical	197 (0.1)	1,599 (46.8)	1,622 (47.5)	<.0001*
Hospital unit of an institution (prison hospital, college infirmary, etc.)	1 (0.2)	0	1 (0.06)	<.0001*
Hospital unit within an institution for persons with intellectual disabilities	0	0	0	<.0001*
Surgical	5 (0.9)	6 (0.3)	7 (0.4)	<.0001*
Psychiatric	120 (22.9)	74 (4.1)	34 (1.9)	<.0001*
Tuberculosis and other respiratory diseases	0	0	1 (0.1)	<.0001*
Cancer	0	5 (0.3)	4 (0.2)	<.0001*
Heart	0	2 (0.1)	5	<.0001*
Obstetrics and gynecology	1 (0.2)	4 (0.2)	2 (0.1)	<.0001*
Eye, ear, nose, and throat	1 (0.2)	1 (0.05)	2 (0.1)	<.0001*
Rehabilitation	81 (15.5)	29 (1.6)	36 (2.0)	<.0001*
Orthopedic	2 (0.4)	9 (0.5)	6 (0.3)	<.0001*
Chronic disease	0	1 (0.05)	0	<.0001*
Other specialty treatment	6 (1.1)	2 (0.1)	2 (0.1)	<.0001*
Children's general medical and surgical	1 (0.2)	17 (0.9)	31 (1.7)	<.0001*
Children's psychiatric	12 (2.3)	6 (0.3)	1 (0.06)	<.0001*
Children's rehabilitation	3 (0.6)	0	3 (0.2)	<.0001*
Children's orthopedic	0	2 (0.1)	6 (0.3)	<.0001*
Children's chronic disease	0	0	1 (0.1)	<.0001*
Children's other specialty	0	2 (0.1)	2 (0.1)	<.0001*
Institution for persons with intellectual disabilities	0	1 (0.06)	0	<.0001*
Acute long-term care hospital	89 (17.0)	58 (3.2)	37 (2.1)	<.0001*
Alcoholism and other chemical dependency	4 (0.7)	4 (0.2)	2 (0.1)	<.0001*

* Statistically significant at $p < .05$.

Hospitals with complete and partial EHR implementation were generally larger, with a higher number of licensed beds, greater numbers of hospital admissions and inpatient days, and greater numbers of Medicare and Medicaid inpatient days compared to

hospitals without EHRs (see Table 3). In terms of staffing, hospitals that reported full EHR implementation had a higher number of nurses, pharmacists, and primary care physicians as well as specialty doctors and overall higher total numbers of full-time personnel than hospitals with partial or no implementation of EHRs. The standard deviation in these continuous variables was found to be large. Such findings are not uncommon or erroneous. In this case, the large standard deviations could be due to a nonnormal distribution of the data, significant variability, or small sample size. Because the data were analyzed using nonparametric means, the results are not affected.

Table 3: Means and Logistic Regression Model Testing Association of Hospital Organizational Structure and Staffing with EHR Implementation

Organizational Structure and Staffing	Mean			*df*	X^2	*p*-value
	No Implementation (SD)	Partial Implementation (SD)	Complete Implementation (SD)			
Total licensed beds	136 (136)	179 (211)	243 (258)	1	10.38	.001*
Total facility admissions	2,039 (3,704)	6,201 (8,688)	9,375 (11,324)	1	17.55	<.0001*
Total facility inpatient days	23,434 (38,120)	35,246 (49,184)	50,713 (62,089)	1	24.44	<.0001*
Total Medicare inpatient days	7,722 (9,980)	15,045 (20,469)	21,354 (27,170)	1	6.79	.009*
Total Medicaid inpatient days	4,437 (12,987)	8,282 (8,356)	11,122 (19,478)	1	2.25	.13
Total surgical operations	1,168 (3,126)	4,908 (6,425)	7,478 (9,695)	1	12.51	.0004*
Total outpatient visits	27,771 (56,645)	127,879 (178,532)	203,899 (294,668)	1	21.91	<.0001*
Full-time staffing	250 (374.1)	753 (1,212)	1,196 (1,815)	1	2.93	.09
Physicians and dentists	4 (17.0)	16 (68)	36 (133)	1	0.73	.39
Registered nurses	57 (109)	200 (330)	316 (459)	1	0.93	.33
Pharmacists	2 (5)	8 (15)	14 (22)	1	10.2	.001*
Total personnel	249 (374)	753 (1,212)	1,196 (1,815)	1	3.45	.06
Specialty doctors						
Primary care (general practitioner, general internal medicine, family practice, general pediatrics, obstetrics/gynecology, geriatrics)	2 (4)	12 (19)	24 (58)	1	5.13	.02*
Emergency medicine	0.4 (3)	2 (7)	5 (13)	1	9.81	.001*
Hospitalists	1 (7)	3 (9)	5 (12)	1	0.001	.99
Intensive care	0.12 (1)	1 (5)	2 (8)	1	5.39	.02*
Radiologist/pathologist/anesthesiologist	0.25 (2)	3 (20)	8 (33)	1	1.08	.30
Other specialists	2 (9)	14 (58)	32 (98)	1	2.02	.15
Total employed physicians	6 (22)	36 (119)	77 (194)	1	1.21	.27

* Statistically significant at $p < .05$.

The multinomial logit model demonstrated a positive association of number of licensed beds, heart hospitals, and children's general medical and surgical hospitals with the likelihood of complete EHR implementation. Conversely, psychiatric and rehabilitation hospitals, limited-service hospitals, hospitals participating in a network, government nonfederal hospitals, and nongovernment not-for-profit hospitals demonstrated less likelihood of complete implementation of EHRs (see Table 4).

Table 4: Multinomial Logit Model Prediction Association of EHR Implementation with Hospital Characteristics: Analysis of Maximum Likelihood Estimates

Hospital Characteristics	Model	Parameter Estimate	*p*-value
Intercept	Complete implementation vs. no implementation	4.34	.004*
	Partial implementation vs. no implementation	5.80	<.0001*
Number of licensed beds	Complete implementation vs. no implementation	0.01	.04*
	Partial implementation vs. no implementation	0.01	.03*
Total facility admissions	Partial implementation vs. no implementation	0.00	.02*
Total full-time personnel	Complete implementation vs. no implementation	0.05	.06
	Partial implementation vs. no implementation	0.05	.06
Government, nonfederal—county	Partial implementation vs. no implementation	-2.32	<.0001*
Government, nonfederal—hospital authority/district	Complete implementation vs. no implementation	-1.82	.04*
Nongovernment, not-for-profit	Complete implementation vs. no implementation	-2.41	<.0001*
Nongovernment, not-for-profit	Partial implementation vs. no implementation	-2.15	<.0001*
Psychiatric	Partial implementation vs. no implementation	-3.56	.01*
Heart	Complete implementation vs. no implementation	11.55	<.0001*
Rehabilitation	Partial implementation vs. no implementation	-4.05	.02*
Children’s general medical and surgical	Complete implementation vs. no implementation	4.04	<.0001*
Limited access hospital	Partial implementation vs. no implementation	-0.65	.04*
Part of network	Complete implementation vs. no implementation	-0.65	.007*
	Partial implementation vs. no implementation	-0.51	.03*

* Statistically significant at $p < .05$.

Discussion

The study findings show that a majority of the hospitals (87.4 percent) in the United States were compliant with EHR implementation either partially or completely. Thus, at the midpoint of the incentive period for EHR implementation, that is, two years after the onset of incentives for demonstration of meaningful use of EHRs under the HITECH Act and two years

before the imposition of penalties for the failure to implement EHRs under the ACA, most hospitals indicated adoption of this health information technology.

The study found that larger hospitals and those with higher number of inpatient days reported higher EHR adoption, while smaller hospitals comparatively fell behind. This finding aligns with previously published research.[14,15] It was also found that hospitals with higher numbers of licensed beds and higher total staff, including physicians, nurses, pharmacists, and technicians, demonstrated higher rates of EHR implementation. One of the barriers to EHR system adoption is often cited to be lack of sufficient technical support, investment of numerous extra hours required to train staff efficiently, and related workflow disruption.[16] Hospitals with higher staffing, also a function of larger size, are better equipped to offset this challenge. It is likely that such institutions may have better financial resources to invest in progressive practices such as the adoption of health information technology. Moreover, larger integrated healthcare centers often have greater incentives for return when making investments in training programs along with additional technical workforce support, in comparison to smaller practices. These factors also explain why smaller practices, such as limited-service hospitals, demonstrated a negative association with EHR implementation in the multinomial logit regression model.

In this study, hospitals with higher numbers of Medicare and Medicaid patient-days were associated with EHR adoption. This finding may indicate willingness to demonstrate meaningful use of EHRs in order to receive financial incentives, thus suggesting a positive impact of the HITECH Act and the ACA. Among the hospitals categorized by service, general medical and surgical hospitals showed the highest rate of complete EHR implementation. These findings were supported by a market research survey of a group of physicians and surgeons.[17] In that survey, although some specialty surgery institutions performing intricate surgical procedures claimed that EHRs pose difficulties, general medical and surgical hospitals claimed otherwise.[18] The report revealed that more than 80 percent of the participating general surgeons expressed the belief that EHR implementation would improve patient safety, lead to better quality of care, reduce administrative costs, improve profitability/financial stability of their practices, and create an environment that would discourage the use of controlled substances.[19] Similarly, our results concurred with evidence that nonprofit and heart (cardiology) hospitals demonstrated a greater likelihood of EHR implementation.[20]

Psychiatry and rehabilitation service hospitals were found to be negatively associated with EHR implementation. Of the 228 psychiatry and 146 rehabilitation hospitals in the AHA database, more than 50 percent had not implemented even basic EHR systems. Similar inferences were confirmed by a previous study determining adoption rates of EHR systems among all types of inpatient providers.[21,22] Mental health and rehabilitation centers are important healthcare delivery mechanisms in the overall healthcare spectrum, providing care to numerous patients annually. It is important for these institutions to implement practices such as the use of health information technology to maintain and improve quality of care. If slow rates of adoption persist in the future, efforts should be made to promote EHR implementation among psychiatric and rehabilitation hospitals.[23]

The results of the regression model suggest a possible gap in EHR system implementation between the non–federal government (county), nongovernment not-for-profit, and nongovernment for-profit hospitals. These medical institutions mentioned in the previous statement, are commonly smaller in size and have more limited financial resources. They often lack personnel with the required leadership skills, knowledge, and technical support to manage such a project. These factors could lead to doubts about EHR implementation and the potential resulting workflow disruption and reduction in work productivity. Further delay in adoption of progressive practices and newer technologies poses the risk of a more extensive technology divide in the future. Failure to adopt EHRs at this time may lead to imposition of penalties and thus present greater challenges in the future in terms of financial resources and access to health information technology.

Limitations

It is necessary to acknowledge the shortcomings of this study in order to draw valid conclusions. The elements of the AHA survey database supplement on health information technology were not available for inclusion in the study. Thus, this evaluation was limited to the AHA survey report of whether or not EHRs were implemented, without a detailed account of meaningful use and outcomes of EHR implementation. Inclusion of the additional health information technology variables would have provided a clearer picture of the impact of the HITECH Act and the ACA as well as hospitals' progress in achievement of stage 1 and stage 2 meaningful use objectives and thereby their preparedness to accept financial incentives. Thus this research could not measure meaningful use of EHRs, the extent of use of EHRs, the processes in which EHRs have been used in the functioning of the hospitals, and whether EHR implementation has led to better healthcare quality. The study

defined “complete implementation” as one in which the “big bang” approach was used, but is it possible that an organization may have used a phased approach to achieve full implementation. The inclusion of phased EHR implementation could change the dynamics of the study, but this variable was not captured in the AHA survey. Also, because the AHA survey is a cross-sectional study, temporal relations to the hospital characteristics cannot be established.

Conclusions

Numerous studies have assessed the degree of meaningful use demonstrated in response to federal incentives using a variety of databases at different points in time before and after the federal initiatives. This study adds constructively to existing literature by using the AHA database in the midst of these health information technology policies to identify characteristics of hospitals implementing EHRs in addition to the extent of implementation. In the future, it is imperative that the findings of similar studies be compared to the current findings to determine levels of change in EHR implementation and to determine if the identified trends in the association of hospital characteristics with EHR implementation continue to exist. If so, policy initiatives targeted toward hospitals with characteristics associated with lower rates of EHR implementation should be furthered to help bridge this gap.

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