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Electronic Clinical Quality Measures of Health Information Technology and Hospital Performance: Evidence of U.S. Hospitals

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ABSTRACT

Electronic clinical quality measures (eCQMs) are an integral part of health information technology (HIT). This study explores the effect of eCQM implementation on hospital performance. The study proposes hospital profitability, efficiency, and quality to measure hospital performance. Based on the literature, this research hypothesizes that implementing eCQMs would positively impact hospital profitability, efficiency, and quality. The sample data are drawn from the 2017 American Hospital Association (AHA) U.S. Hospital Survey datasets (N = 6282), the 2017 AHA U.S. Hospital I.T. Survey dataset (N = 3451), and the 2017 Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) datasets (N = 4345). This paper also analyzes the effect of four control variables in the profitablity models – hospital bed size, location, ownership, and teaching status. The study uses multiple regression models to test the hypotheses. Data strongly supports Hypothesis 1 (profitability), moderately supports Hypothesis 2 (efficiency), and does not support Hypothesis 3 (quality). Control variables show mixed results. Both theoretical and practical implications are discussed. Implications and future directions for this research shed light on the potential benefits of implementing eCQMs in hospitals.

Keywords: eCQMs, hospital profitability, hospital efficiency, hospital quality

INTRODUCTION

The hospital and healthcare industry in the United States play a crucial role in providing essential medical services and care to individuals across the nation. Hospital performance matters because it directly affects the health and well-being of individuals within communities. However, as the healthcare industry continues to evolve and face various challenges, hospital performance is a significant concern for healthcare executives and policymakers (Nigam, 2014). Understanding how hospital performance can be improved has become imperative.

Hospital performance encompasses multiple dimensions, including profitability, efficiency, and quality. Hospital profitability enables hospitals to purchase the latest technologies that recruit the best physicians and attract insured patients (Benton, 2013). Hospital facilities equipped with the latest technology and ample bed capacity enables physicians to treat patients quickly. Enhanced hospital efficiency and quality align with the policy objective of minimizing the pace of healthcare cost inflation while upholding high quality standards. To succeed in healthcare delivery

today, it is imperative to achieve a balance between providing quality service and the optimization of efficiencies (Steinberg, 2006). Businesses, including hospitals, strive to maximize shareholders' returns, so a combination of efficiency, effective use of resources, and patient satisfaction is vital to optimizing investment returns as it relates to hospitals.

eCQMs are valuable tools for measuring and tracking the quality of healthcare services in medicare eligible hospitals and critical access hospitals (CAHs), and consists of the parts: the data model, expression logic, and the structure (eCQI, 2023a; see Figure 1) They ensure effective, safe, efficient, patient-oriented, equitable, and timely provision of services in our health care system (CMS, 2023). The long-term quality of healthcare can be improved using eCQMs data. There are several ways to analyze eCQMs data, with results that vary depending on whether the data originate from individual electronic health records (EHRs) or a health information exchange (HIE) serving as a multisource registry. eCQMs can play a significant role in the efficiency and quality of healthcare offerings. According to a recent survey funded by the government, which involved over 2,600 doctors in the U.S., it was found that 82% of doctors utilize EHRs (Bardhan & Thouinm, 2013). By accessing a patient's information across various platforms, doctors are better able to efficiently monitor their patients' performance and collaborate with other providers to give their patients the best possible care. Using eCQMs helps eliminate misdiagnoses and possible catastrophic outcomes, which can otherwise result from miscommunication.

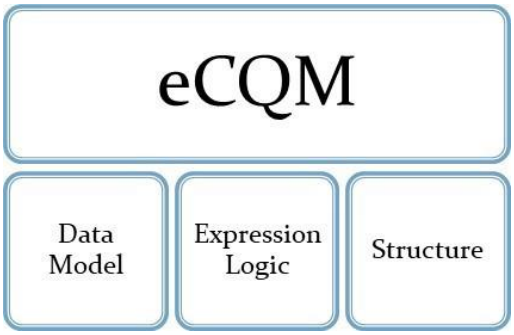

Figure 1. Electronic Clinical Quality Measures Tool Architecture

Based on the importance of eCQMs in the performance and delivery of quality healthcare to patients, the primary purpose of our study is to explore whether implementing hospital eCQMs leads to increased hospital performance, specifically in terms of profitability, efficiency, and quality. By examining the impact of eCQMs on these dimensions, we aim to evaluate the potential benefits and advantages that hospitals may experience by incorporating eCQMs into their

healthcare systems. This study will contribute to understanding how eCQMs can influence hospital operations and patient outcomes, ultimately providing insights into the value and effectiveness of utilizing eCQMs in hospital settings.

LITERATURE REVIEW

eCQMs and Hospital Profitability

The American Hospital Association (AHA, 2005) published research on hospital information technology (I.T.) usage. According to the findings of the study conducted by the AHA, hospitals that made the most use of information technology had more significant average margins than other hospitals, and hospitals that had positive margins made the most use of I.T. eCQMs is part of hospital information technology; therefore, the usage of the eCQMs in hospitals may assist in increasing profits.

Nelson and colleagues (1992) investigated the relationship between patient quality measurement evaluations and hospitals' profitability based on data collected from 51 general medical/surgical hospitals owned by the Hospital Corporation of America (HCA). Using multiple regression analysis, meeting patients' expectations recorded via eCQMs positively related to hospitals' financial performance.

Based on the findings by Gardner (2009), it is evident that implementing additional technology, such as EHR systems, can be profitable in a healthcare system. Small medical centers have the opportunity to explore supplementary revenue streams by eCQM systems within their EHRs infrastructure to enhance the efficiency of their recordkeeping processes. Implementing an inhouse recordkeeping system allows a small practice to focus on its clientele, work on clinical trials, and engage in other medical research. Access to high-end recording equipment allows for more enhanced and practical client management while providing access to funding and payments for hosting clinical trials and opportunities for new medical breakthroughs.

Previous research focuses on outcomes associated with cost reduction. Expanding on prior research, Bardhan and Thouin (2013) explored the effect of using I.T., such as health information technology (HIT), on healthcare quality. They studied the association between HIT and healthcare quality among healthcare providers. They evaluated the impact of HIT usage on evidence-based, process-specific healthcare quality measures and, by extension, its economic impact on the institution. The

study found that the implementation of I.T. quality measures has reduces operating expenses, which positively impacts the institution's bottom line, if ever so slightly. The outcome also depends on the type of institution, be it a non-profit institution or a for-profit institution, but nonetheless, the results demonstrate a positive effect. Strategically placing electronic system upgrades results in cost savings. Eliminating redundant costs and creating a more efficient system helps offset the cost of implementing the system.

Hypothesis 1: Implementation of eCQMs is positively related to hospital profitability.

eCQMs and Hospital Efficiency

Ferrier and Trivitt (2013) examine the impact of accounting for eCQMs on efficiency scores. The sample for this study consists of 1,074 US general hospitals operating in 2005. The study omits hospitals that did not treat at least 25 patients for each of the four outcome measures; acute myocardial infarction, congestive heart failure, pneumonia, and gallbladder removal. Data envelopment analysis (DEA) measures the efficiency of producing quality on multiple dimensions, the overall measure of quality, process quality, and outcome quality. The findings of this study demonstrate the positive relationships between the implementation of eCQMs and the levels of efficiency – hospitals that incorporate more eCQMs in hospital facilities tend to exhibit higher levels of efficiency.

According to Hagen and Richmond (2008), the healthcare system can only function with reliable information. It is very challenging to successfully organize health records due to the complexity of the U.S. healthcare system, which includes many different types of providers, services, and locations for care. HIT has the potential to significantly increase the efficiency and productivity of the health industry by helping healthcare institutions with data management. eCQMs are part of HIT, and findings indicated that HIT led to higher hospital efficiency. Thus, the study suggests that eCQMs may positively affect hospital efficiency.

Steinberg (2006) emphasized that there is a growing body of evidence highlighting the substantial benefits of utilizing informationt in the reduction of medical errors. This reeduction in medical errors is crucial since it can literally mean the difference between life and death. Fewer errors translate to a reduced need for redundant tests or medical procedures, saving valuable time and resources. Steinberg (2006) underscored that the implementation of HIT positively correlates to enhanced hospital efficiency. Consequently, the study suggests that the integration of eCQMs

into the healthcare process contributes to improved efficiency, leadng to cost reduction and positively impacting hospitals' financial performance.

Hypothesis 2: Implementation of eCQMs is positively related to hospital efficiency.

eCQMs and Hospital Quality

Hagen and Richmond (2008) demonstrate that the effective implementation and utilization of EHRs may lead to an elevation in the standard of medical care. According to their study, EHRs have the capacity to positively impact various facets of patient care. These benefits include educating clinicians about essential preventative care, identifying potential risks associated with drug interactions, recognizing adverse reactions to prescribed medicines, and assisting physicians in effectively managing patients with complex chronic diseases. Furthermore, other experts in the healthcare industry contend that while there may not be a significant shift in healthcare expenditures, there is a noticeable and modest increase in the quality of care provided. EHRs are a component of eCQMs suggesting that the adoption of eCQMs holds the potential to further enhance the quality of patient care.

Weiner et al. (2006) study potential correlations between implementing eCQMs, hospital improvements, and hospital performance quality. Theyanalyzed data from 1,784 hospitals sourced from multiple secondary data sets regarding managed care penetration and hospital financial performances. The findings from a series of regression analyses support the hypothesis that the implementation of eCQMs in hospitals is significantly positively correlated with hospital performance quality.

Chakravorty (2018) reports that financial performance measurement is crucial for healthcare providers in in maintaining their viability and ensuring proper patient care. Both care-quality and performance are interdependent, , and higher revenues and cash flows form significant aspects of the healthcare network that can be boosted by utilizing information technology. Hospitals are increasingly adopting technologies like EHR and Enterprise Resource Planning (ERP) platforms to form better synergies with their suppliers, ultimately leading to improved healthcare quality and patient benefits, while simultaneously enhancing performance indicators. Based on findings, Chakravorty (2018) developed three propositions that emerged as key principles in the healthcare industry; EHR adoption has a positive relationship with care quality in a hospital’s supply chain network, ERP adoption has a positive relationship with care quality in a hospital’s supply chain

network, and care quality has a positive relationship with healthcare performance in the hospital supply chain network.

Implementing HIT in hospitals and healthcare systems has significantly impacted the delivery of quality healthcare. Bardhan and Thouin (2013) shed light on the impact of HIT on patient care quality, noting that while many studies have primarily focused on its direct financial impact, a more comprehensive perspective emerges when considering its influence on patient care. Their study highlighted specific areas where HIT has a positive impact on patient care, including patient monitoring, problem lists, medication lists, allergy lists relative to medication, and electronic clinical data exchange among providers. The latter reduced or eliminated errors and improved patient care delivery, potentially saving lives.

Hypothesis 3: Implementation of eCQMs is positively related to hospital quality.

METHODOLOGY

Sample

The sample for this study is collected from three different data sources. The first is the 2017 AHA U.S. Hospital dataset, which surveyes approximately 6,000 participating hospitals. This dataset includes various measures that are related to hospital profitability and efficiency. Concerning profitability, the dataset includes operating margin, ROA, and ROE metrics. Regarding efficiency, the dataset includes metrics such as capacity and manpower productivity.

The second data source is the 2017 AHA U.S. Hospital I.T. Survey dataset that includes the metrics regarding eCQM devices in hospitals.

The last data source is the 2017 Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) on Medicare.org. This survey includes about 2,000 participating hospitals and measures related to hospital quality, such as patient satisfaction rates, hospital overall satisfaction rates, serious complications, and readmission rates.

Hospital Performance Variables

In this study, hospital performance is assessed using three broad variables: (1) hospital profitability, (2) hospital efficiency, and (3) hospital quality. Table 1 provides different indicators used to capture each of the variables, meanings, sources utilized, and the calculation methods of each indicator.

Table 1. Variables Used to Measure Different Aspects of Hospital Performance

Variables	Indicators	Meanings	References & Sources	Measures
Hospital Profitability	Operating Margin (O.M.)	a crucial statistic indicator that determines how profitable the hospital is	Lee et al. (2022), Watkins (2000)	*[(Total Revenue - (Operating Expense + Taxes Paid)]/ Total Revenue*
	Return on Assets (ROA)	a metric that can be applied to measure how a hospital is profitable in comparison to their total assets		*Net income ÷ total Assets (at yearend)*
	Return on Equity (ROE)	a metric that can be applied to measure how a hospital is profitable using their equity		*Net Income ÷ Equity (at year-end)*
Hospital Efficiency	Occupancy Rate (OCCP)	hospital capacity usage and determines how many workers supply inpatient services	Watkins (2000)	*Number of Patient Days / (Number of Beds x 365)*
	Capacity Productivity (C.P.)	the connection between the amount of inpatient activity generated by each bed and the overall output		*CMAAD / # of Beds*, where *CMAAD = Case Mix Index x # of Admissions*
	Manpower Productivity (M.P.)	how efficient is a hospital compared to other hospitals based on FTEs		*CMAAD / # of FTE Staff*
Hospital Quality	Patient Satisfaction Rate (Q_HR1)	Overall hospital rating-star rating; Survey question #19 “Would you recommend this hospital to your friends and family?”; The higher the score, the better the hospital quality.	Retrieved from "HCAHPS-Hospital.csv" in the 2017 Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) patient survey data on the Center for	1 to 4 Likert scale, being 1 as “Definitely No” and 4 as “Definitely Yes”

	Hospital Overall Satisfaction Rate (Q_HR2)	Overall hospital rating-linear mean score; Survey question #18. “Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?”	Medicare and Medicaid Services (CMS) website	0 to 10 Likert scale, being 0 as “Worst hospital possible” and 10 as “Best hospital possible”
	Serious Complications (Q_SC)	The higher the score, the worse the hospital quality.	Retrieved from "Complication & Death- Hospital.csv" in the 2017 HCAHPS dataset	A composite score scaled by CMS; Extracted from datapoint valued "PSI-90"
	Readmission Rate (Q_RR)	The higher the score, the worse the hospital quality.	Retrieved from "READM_30_HOSP_WIDE.csv" file in the 2017 HCAHPS dataset	Estimates (Rates %) of unplanned readmission to an acute care hospital in the 30 days after discharge from a hospitalization.

eCQMs Variable

eCQMs are measuring tools and devices specifically designed for standard electronic format. eCQMs use electronically extracted data from electronic health records (EHRs) and health information technology (I.T.) systems to measure the overall quality of healthcare provided in hospitals and healthcare offices. The Center for Medicare and Medicaid Services (CMS) uses eCQMs in various ways to calculate quality reporting and value-based purchasing programs to better assist hospitals in various locations across the country based on information from ECQI Resource Center (2023b).

The American Hospital Association (AHA) uses three variables for assessing the implementation of eCQMs: Medicare Inpatient Quality Reporting, Physician-Specific electronic clinical quality measures (eCQMs), and Hospital-Specific measures (eCQMs). Respondents were asked to rate these variables on a scale of 1 to 4, where 1 indicates Fully or Primarily Automated, 3 indicates Fully or Primarily Manual, and 4 indicates Do Not Know/N.A. For the current study, we created eCQMs measures by combining the three items: Medicare inpatient quality reporting, physicianspecific electronic clinical quality measures, and hospital-specific measures. Specifically, we first recorded (1) wholly or primarily automated to a score of 7, (2) a mix of the automated and manual process into a score of 4, (3) wholly or primarily manual into a score of 2, and (4) not available into a score of 1. Then we calculated the average scores of these three items to calculate the overall measure.

Control Variables

We included bed size (BDTOT), geographic locations (Metro, Micro, and Rural), types of ownership (Government, For-Profit, and Not-For-Profit hospitals), and teaching status as control variables because these variables generally correlate with hospital performance.

RESULTS

Hospital Profitability

As shown in Table 2, eCQMs are statistically correlated with all hospital profitability measures. For example, eCQMs are positively correlated with Operating Margin (O.M.; $R = .121$, $p < .001$), Return on Assets (ROA; $R = .086$, $p < .001$), and Return on Equity (ROE; $R = .096$, $p < .001$).

Table 3 presents the results of the multiple regression analyses testing Hypothesis 1. The first regression model tests the sample data ($n = 2633$) and include the eCQMs, the primary independent variable, and four control variables – bed total, location, ownership, and teaching status- to estimate the dependent variable, O.M. The overall regression model is statistically significant [$R2adj = .116$, $F = 50.251$, $p < .001$]. After including the four control variables, we found a positive relationship between hospitals with eCQMs and O.M. (Standardized Regression Coefficient $\beta = .100$, $p < .001$). Among the control variables, BDTOT, Metro, For-profit were positively related to O.M. while Rural, Government-owned (Govt), and Teaching hospital (Teaching) were negatively related to O.M

Table 2. Descriptive Statistics and Correlations for Profitability Variables

	Mean	SD	N	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) OM	-1.00	12.74	5089												
(2) ROA	4.08	10.07	4779	.640***											
(3) ROE	7.98	14.94	4606	.396***	.649***										
(4) eCQMs	0.61	.49	3025	.121***	.086***	.096***									
(5) BDTOT	149.86	187.68	6282	.051***	.076***	.042**	.112***								
(6) Metro	0.68	.47	6282	.223***	.141***	.135***	.069***	.323***							
(7) Micro	0.14	.35	6282	-.031*	-.050***	-.067***	-.006	-.137***	-.588***						
(8) Rural	0.18	.39	6282	-.240***	-.123***	-.101***	-.080***	-.268***	-.682***	-.191***					
(9) Govt	0.23	.42	6282	-.259***	-.134***	-.131***	-.129***	-.027*	-.223***	.048***	.228				
(10) NFP	0.50	.50	6282	-.050***	-.023	-.038**	.127***	.153***	-.019	.044***	-.017	-.549***			
(11) For-Profit	0.27	.44	6282	.270***	.154***	.164***	-.025	-.147***	.234***	-.095***	-.198	-.331***	-.607***		
(12) Teaching	0.05	.21	6282	-.037**	.032*	.010	.046*	.504***	.150***	-.085***	-.106	.045***	.072***	-.124***	

Note: SD = Standard Deviation, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$ (One-tailed)

Table 3. Regression Model Results on Hospital Profitability

Dependent Variable	**Operating Margin**	**Return On Assets**	**Return On Equity**
eCQMs	.100***	.073***	.079***
BDTOT	.045†	.043†	.027
Metro	.067**	.086**	.105***
Rural	-.095***	.017	.032
Govt	-.134***	-.065**	-.081***
For-profit	.163***	.110***	.084***
Teaching	-.082***	.016	.001
R^2	.118	.042	.041
R_{2adj}	.116	.040	.038
F	50.251***	15.797***	14.668***
C.I.	7.053	7.024	6.984
N	2633	2512	2427

Note: †$p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; Standardized regression coefficient BETA are reported;
C.I. = Condition Index.

The second regression model analyzes the sample data (n = 2512), to estimate ROA. The overall model is statistically significant [R2adj = .040, F = 15.797, p < .001]. eCQMs is significantly related to ROA (β = .073, p < .001). Among the control variables, BDTOT, Metro, For-profit are positively related to ROA while Govt is negatively related to ROA.

The third regression model utilizes the sample data (n = 2427) to estimate ROE. The overall model is statistically significant [R2adj = .038, F = 14.668, p < .001]. eCQMs is significantly related to ROE (β = .073, p < .001). Among the control variables, Metro and For-profit are positively related to ROE while Govt is negatively related to O.M.
In sum, the results of the three regression models strongly support Hypothesis 1

Hospital Efficiency

Table 4 shows mixed results on the correlations between eCQMs and three efficiency measures. eCQMs are statistically positively correlated with Manpower Productivity (M.P.; R = 096, p < .001) and Capacity Productivity (C.P.; R = .091, p < .001), while eCQMs are not correlated with Occupancy Rate (OCCP; R = .020, n.s.).

Table 5 presents the results of the multiple regression analyses testing our Hypothesis 2. The first regression model tests the sample data (n = 3021) to estimate OCCP. The overall regression model is statistically significant [R2adj = .253, F = 146.984, p < .001]. After including the four control variables, we find a negative relationship between hospitals with eCQMs and OCCP (β = -.039, p < .05). Among the control variables, BDTOT and Metro are positively related to OCCP while Rural and For-profit are negatively related to OCCP.

The second regression model analyzes the sample data (n = 1936) to estimate M.P. The overall regression model is statistically significant [R2adj = .314, F = 127.543, p < .001]. We find a positive relationship between eCQMs and M.P. (β = .044, p < .05). Among the control variables, BDTOT, Metro, Rural, For-profit are positively related to M.P. while Govt and Teaching are negatively related to M.P.

The third regression model utilizes the sample data (n = 1947) to estimate C.P. The overall regression model is statistically significant [R2adj = .284, F = 111.323, p < .001]. We find a positive relationship between eCQMs and C.P. (β = .044, p < .05). Among the control variables, BDTOT, Not-for-profit (NFP), and Teaching are positively related to C.P. while Rural and Govt are negatively related to M.P.

In summary, despite the OCCP not supporting Hypothesis 2, the results of the other two efficiency measures (M.P. and C.P.) provide sufficient evidence in support of Hypothesis 2.

Table 4. Descriptive Statistics and Correlations for Hospital Efficiency Variables

	Mean	SD	N	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) OCCP	.56	.22	3335												
(2) MP	12.19	5.23	1974	.310***											
(3) CP	74.11	29.14	1984	.590***	.516***										
(4) eCQMs	.612	.49	3025	.020	.096***	.091***									
(5) BDTOT	178.98	210.69	3340	.408***	.253***	.346***	.112***								
(6) Metro	.68	.47	3340	.384***	.415***	.436***	.069***	.366***							
(7) Micro	.15	.36	3340	-.165***	-.304***	-.290***	-.006	-.172***	-.613***						
(8) Rural	.17	.38	3340	-.321***	-.257***	-.317***	-.080***	-.291***	-.659***	-.189***					
(9) Govt	.21	.41	3340	-.061***	-.277***	-.208***	-.129***	-.057***	-.228***	.060***	.227***				
(10) NFP	.59	.49	3340	.025	-.003	.192***	.127***	.144***	.028	.021	-.055**	-.621***			
(11) For-profit	.20	.40	3340	.032	.263***	-.044	-.025	-.118***	.200***	-.087***	-.165***	-.259***	-.597***		
(12) Teaching	.07	.25	3340	.234***	-.021	.270***	.046*	.540***	.180***	-.107***	-.122***	.037*	.067***	-.120***	

Note: SD = Standard Deviation, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$ (One-tailed)

Table 5. Regression Model Results on Hospital Efficiency

Dependent Variable	**Occupancy Rate**	**Manpower Productivity**	**Capacity Productivity**
eCQMs	-.039*	.044*	.044*
BDTOT	.321***	.282***	.146***
Metro	.212***	.389***	.289
Rural	-.077***	.085*	-.120***
Govt	.000	-.152***	-.085***
For-profit	-.033*	.222***	
NFP			.081**
Teaching	.030	-.193***	.134***
R^2	.255	.317	.287
R_{2adj}	.253	.314	.284
F	146.984	127.543	111.323
C.I.	7.214	12.347	9.417
N	3021	1936	1947

Note: $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; Standardized regression coefficient BETA are reported; *C.I.* = Condition Index

Table 6. Descriptive Statistics and Correlations for Hospital Quality Measures

	Mean	SD	N	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Q_HR1	3.55	.95	1802													
(2) Q_HR2	88.63	3.10	1802	.948***												
(3) Q_SC	.993	.19	1638	-.202***	-.216***											
(4) Q_RR	15.32	.79	2208	-.340***	-.348***	.246***										
(5) eCQMs	.612	.49	3025	-.048*	-.059**	-.021	.055**									
(6) BDTOT	187.14	217.30	3025	-.139***	-.154***	.167***	.183***	.112***								
(7) Metro	.67	.47	3025	-.121***	-.126***	.062**	.091***	.069***	.389***							
(8) Micro	.16	.36	3025	-.004	.004	-.066**	-.082***	-.006	-.184***	-.613***						
(9) Rural	.17	.38	3025	.184***	.181***	-.005	-.032	-.080***	-.306***	-.653***	-.198***					
(10) Govt	.21	.41	3025	.021	.021	.116***	.006	-.129***	-.068***	-.220***	.051**	.224***				
(11) NFP	.63	.48	3025	.106***	.086***	.000	-.107***	.127***	.116***	.063***	.005	-.083***	-.674***			
(12) For Profit	.16	.37	3025	-.156***	-.130***	-.102***	.140***	-.025	-.078***	.162***	-.063***	-.140***	-.224***	-.569***		
(13) Teaching	.07	.26	3025	.012	.001	.145***	.148***	.046**	.542***	.192***	-.114***	-.129***	.036*	.049**	-.105***	

Note: SD = Standard Deviation, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$ (One-tailed); Q_HR1 = Hospital Ratings 1; Q_HR2 = Hospital Ratings 2; Q_SC = Serious Complications; Q_RR = Readmission Rate.

Table 7. Regression Model Results on Hospital Quality

Dependent Variable	**Patient Satisfaction Rate**	**Overall Hospital Satisfaction Rate**	**Serious Complications**	**Readmission Rates**
eCQMs	-.012	-.024	-.020	.039†
BDTOT	-.186***	-.197***	.115***	.154***
Metro	.020	.014	.011	-.047
Rural	.149***	.141***	-.041	-.062*
Govt	.046	.042	.108	-.060*
For-profit	-.112***	-.088**	-.064*	.118***
Teaching	.116***	.114***	.056	.075**
R^2	.075	.071	.050	.065
R_{2adj}	.072	.067	.046†	.062
F	20.869	19.501	12.324	21.942
C.I.	8.644	8.644	12.384	7.148
N	1802	1802	1638	2208

Note: $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; Standardized regression coefficient BETA are reported; *C.I.* = Condition Index.

Hospital Quality

According to Hypothesis 3, we expect eCQMs to be positively correlated with Patient Satisfaction Rate (Q_HR1) and Hospital Overall Satisfaction Rate (Q_HR2) and negatively correlated with Serious complications (Q_SC) and Readmission Rate (Q_RR). As shown in Table 6, eCQMs are negatively correlated with Q_HR1 ($R = -.048$, $p < .05$) and Q_HR2 ($R = -.059$, $p < .01$) but are positively correlated with Q_RR ($R = .055$, $p < .01$). No correlation is found between eCQMs and Q_SC ($R = -.021$, n.s.). Thus, correlations analysis results do not support Hypothesis 3.

Table 7 presents the results of the multiple regression analyses testing Hypothesis 3. All four regression models show no statistical significance on the eCQMs variable. In the fourth model, eCQMs is marginally significant on Readmission Rate but the sign of the coefficient is positive. Because a reduced readmission rate means higher quality, a negative sign is expected on this coefficient. Therefore, the result of this regression analysis does not support Hypothesis 3.

In sum, the results of the four regression models fail to support Hypothesis 3.

DISCUSSION

This study aims to explore the effects of eCQMs on different aspects of hospital performance. Our results strongly support Hypothesis 1 that eCQM implementation positively affects hospital profitability. All three profitability measures (O.M., ROA, ROE) show statistical significance. Among the control variables in the profitability models, BDTOT is generally marginally significant, while Metro, Govt, and For-Profit are significant. The results are consistent with the literature that adding eCQMs to a hospital's operation often produces positive outcomes related to the hospital's financial performance.

The results support Hypothesis 2, suggesting that eCQM implementation positively affects hospital efficiency. Based on the correlation analysis, eCQMs are not correlated with OCCP but are significantly correlated with M.P. and C.P. measures. The results of the regression models also demonstrate that eCQM implementation is significantly and positively related to M.P. and C.P. but negatively related to OCCP. Among the control variables in the efficiency models, BDTOT, Metro locations, Rural locations, Government Hospitals, and Not-For-Profit Hospitals are all statistically significant. However, Micro locations, For- Profit- Hospitals, and

Teaching Hospitals did not attain statistical significance. These research results are consistent with previously discussed literature (Ferrier & Trivitt, 2013; Grossu, 2019; Hagen & Richmond, 2008; Steinberg, 2006), which also demonstrate how how increased eCQM utilizations in hospital facilities leads to higher levels of efficiency. It is logical that Manpower and Capacity Productivity have a more substantial impact on efficiency compared to occupancy rate. Regardless of whether a hospital's occupancy is high or low, it can still operate efficientlwhen it maintains an appropriate balance of Manpower and Capacity Productivity to accommodate the occupancy rate.

The results do not support Hypothesis 3, which proposes that eCQM implementation is positively related to hospital quality. Based on the correlation analysis, eCQMs are significantly and negatively correlated with patient satisfaction and hospital overall satisfaction rates, not significantly correlated with serious complications, and significantly and positively correlated with readmission rates. The results of the regression models also demonstrate that eCQM implementation is not related to patient satisfaction rate, hospital overall satisfaction rate, or serious complications but marginally and positively related to readmission rate.

This study presents several limitations that offer opportunities for future research. First, Hypothesis 3 is not supported by the results of this study. The results contradict our hypothesis, so future research is needed to validate and explore the negative relationships.

Second, this study focuses exclusively on the impact of eCQM implementation on hospital performance. Future research would be valuable to explore the underlying mechanisms and boundary conditions that could potentially modify these relationships using a more advanced statistical technique such as SEM-PLS.

Third, the data used in this study is derived from hospitals in the U.S. Due to financial and time constraints, the conclusions of our study are limited in scope. A possible avenue for future research would be to collect international data ato assess whether eCQM implementation has the same effect on hospital profitability, efficiency, and quality in other countries. Given the diverse standards, protocols, and legal frameworks across different nations, these factors could introduce variations to the data, possibly resulting in different findings.

Despite these limitations, this study contributes to the literature by examining the advantages of implementing eCQMs in hospitals. Understanding the impact of

eCQM implementation will allow hospitals to better leverage these programs, such as Medicare or Medicaid, resulting in a similarly positive impact on other hospitals.

CONCLUSION

Based on the findings of this paper, the current study offers valuable insights into the significance of implementing eCQMs in hospital settions. The positive effects of eCQMs on various aspects of hospital performance such as hospital profitability and efficiency prove that technological innovations like eCQMs help the healthcare process and positively impact the communities they serve.

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