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Hospital Meaningful Use Incentive Dollars and HIT-Related Capital Expenditures

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Précis:

Hospital Meaningful Use incentives were positively correlated with health information technology-related capital expenditures.

Take-Away Points:

- No other known research has demonstrated a relationship between the Hospital MU incentive program and HIT-related capital expenditures.
- Our main finding that showed a positive correlation between MU incentives and HIT-related capex may provide some support for policy-makers evaluating the effectiveness of the MU incentive program to stimulate HIT-related capital investments at hospitals and offset some of those hospital costs.
- Our second most important finding that demonstrated hospital executives increased and then decreased HIT-capital spending as the MU incentive dollars increased and then decreased highlights a need to understand whether the MU incentives appropriately prepared hospitals for EHR adoption.

Were Hospital Meaningful Use Incentive Dollars Associated with More HIT-Related Capital Expenditures?

Abstract

Background

In 2009, Public Law 111–5 created the Meaningful Use (MU) program offered by both Medicare and Medicaid to encourage hospitals and eligible providers to adopt and use Electronic Health Records (EHRs). The Medicare MU program began offering financial incentives for attestation in 2011 and began imposing penalties for failing to attest in 2015. The significant capital investments required to adopt EHRs promoted through MU has been cited as a reason for hospitals not re-attesting to MU. This study investigates whether Meaningful Use (MU) incentive dollars to hospitals are associated with hospital Health Information Technology (HIT)-related capital expenditures.

Methods

Ordinary least squares regression on a panel of data from 2010 – 2017 was used to determine whether MU incentive dollars were associated with HIT-related capital expenditures. The sample was limited to hospitals that received at least one MU incentive payment and reported at least one year of HIT-related capital expenditures during the sample period (n=1,750). The key outcome measure was HIT-related capital expenditures (log transformed). HIT-related capital expenditures came from the CMS Hospital Cost Report Information System and MU data came from the CMS Eligible Hospital Recipients of Medicare EHR Incentive Program Payments.

Results

MU incentives were positively correlated with HIT-related capital expenditures (capex). After controlling for other factors and relative to 2010, HIT capex increased between 2011 and 2014 before decreasing in 2016 and 2017 (no significant change in 2015).

Conclusions

Our findings may provide support for the efficacy of the MU incentive program to stimulate hospital EHR adoption and use. More work is needed to determine whether HIT-capex and the MU incentive program impacted hospital profitability.

Key words: meaningful use; promoting interoperability; capital spending; EHRs;

BACKGROUND

In 2009, Public Law 111–5 created the Meaningful Use (MU) program offered by both Medicare and Medicaid to encourage hospitals and eligible providers to adopt and use Electronic Health Records (EHRs).[1] The Medicare MU program began offering financial incentives for attestation in 2011 and began imposing penalties for failing to attest in 2015.[2] This paper focuses specifically on the MU incentive dollars paid through the Eligible Hospital Medicare MU program. (See Figure 1.) The goal of Meaningful Use was to improve health quality outcomes through effective and ubiquitous electronic health record (EHR) adoption. This program offered financial incentives to hospitals and providers to mitigate the significant upfront and ongoing expenses associated with meaningful EHR adoption. The CMS's commitment to promoting meaningful EHR performance has continued with the 2019 Promoting Interoperability Program.[3]

Figure 1: Meaningful Use Incentive Programs

Public Law 111–5 The American Recovery and Reinvestment Act (ARRA) Including the Health Information Technology for Economic and Clinical Health (HITECH) Act	
↓ **Meaningful Use Programs**	
↓	↓
Medicare Incentives / Penalties for: ↓ **Eligible Hospitals (EHs)** | ↓ Eligible Providers (EPs)	Medicaid Incentives for: ↓ Eligible Hospitals (EHs) | ↓ Eligible Providers (EPs)
Incentive: No Adopting, Implementing, or Upgrading Incentive **1. Effective MU Adoption (Stages 1–3) (2011–2015)**	Incentives: 1. Adopting, Implementing, or Upgrading Incentive 2. Effective MU Adoption (Stages 1–3) (2011–2016)
Penalties: 1. Payment Adjustments for Failed Adherence (As early as 2015)	Penalties: None

The significant capital investments required to adopt EHRs promoted through MU has been cited as a reason for hospitals not re-attesting to MU.[4] The decision for hospital leaders to invest into health information technology (HIT)-related capital expenditures (capex) can be complex. Failing to invest into HIT-related capex could have led to reduced MU incentive receipts and penalties, which could negatively impact profits. However, MU incentives were not intended to subsidize the entire cost of EHR adoption, meaning the increase in HIT-related capital and operating spending could also negatively impact profits. Similarly, previous research has not

consistently supported the relationship between EHR use and cost savings for hospitals.[5-9] One study suggests that significant cost savings from EHR use will only come after the proper alignment of incentives in the health care system, with strong leadership, and with focused efforts and effective implementation strategies to achieve interoperability.[10]

Despite the MU incentive payments, significant costs associated with implementation of EHRs include equipment purchase, chart pulls, new chart creation costs, filling time, support staff, transcription, and training.[11] Once implemented, however, the costs continue as the needs for upgrades, maintenance, analytics, and patient engagement require active and ongoing management.[12,13] However, proponents hope that hospitals will achieve improvements to cost, efficiency, and quality through improved legibility of records, reduced prescription errors, improved adherence to best clinical practice guidelines, improved patient and clinician access to records, and by allowing exchange of health information.[14]

Meaningful use is based on three stages, which have been modified since original inception.[1] Components include protecting patient health information, using clinical decision support, using computerized provider order entry, electronic prescribing, medication reconciliation, and others.[15] In essence, MU is a term and metric to determine a hospital's EHR functionality.

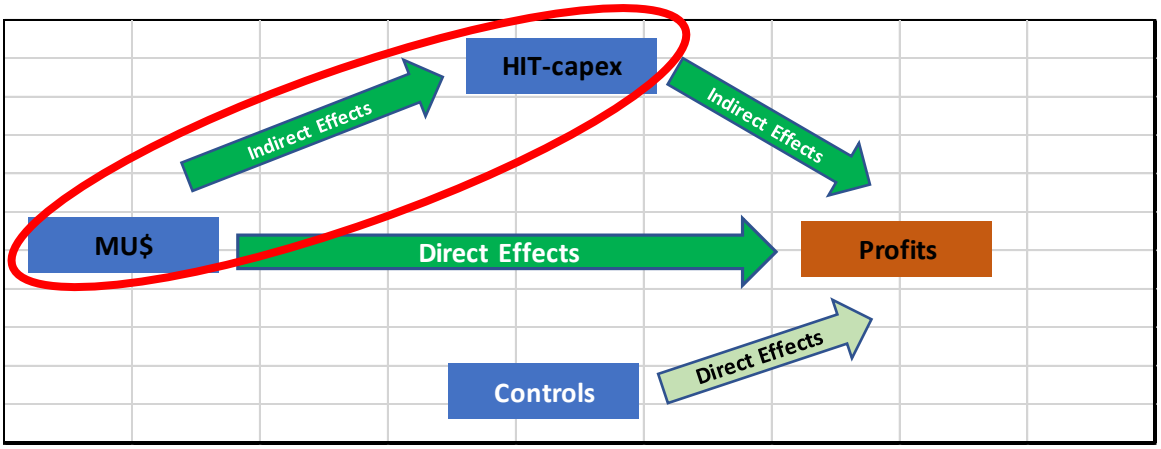
Previous studies explored the intention and evaluation of MU incentives.[4,15-19] One study found that EHR use was associated with improved hospital financial performance, yet it was noted that this may be the result of MU incentive payments.[20] Another study reported that hospitals ineligible for MU incentive payments such as psychiatric, long-term care, and rehabilitation, are less likely to adopt and use EHR systems.[21] Similarly, Appari and colleagues found that in 2011, hospitals that could meet MU standards saw improvements in process quality, yet hospitals that transitioned to more advanced EHR systems experienced quality declines.[18] Yuan and colleagues found that hospitals with EHRs performed significantly better in five of eleven process measures, but not better in overall metrics of quality such as readmission or mortality rates.[15] Adler-Millstein found that higher level EHR use was associated with better performance in patient satisfaction and process metrics related to quality, but not efficiency.[17] The results of these studies overall show promise for the use of advanced EHRs, but not consistent overall process improvement.

There are no known studies evaluating the historic relationship between the MU incentive program and HIT-capex, although previous studies have explored the intention and evaluation of the MU incentives.[4,16,19] Of those, Dranove et. al. found some support for a relationship between MU incentives and EHR adoption.[19] Though that study focused on different measures and initial EHR adoption, not the entire MU incentive program.[19] Another study found that EHR use was associated with improved hospital financial performance; yet it was noted that this may have been the result of MU incentive payments.[20] The lack of knowledge determining whether the MU incentive program was associated with changes in HIT-related capex led us to conduct this research on the matter.

The purpose of this study is to examine the association between the CMS hospital Meaningful Use incentive payments and HIT-related capital spending at hospitals. This study may benefit hospital boards and executives retrospectively evaluating capital requirements associated with MU receipts and preparing for future policy-motivated incentive programs. Additionally, policy-makers may benefit from this study by understanding more about the impact of MU

requirements on hospital-level capital spending and ultimately, hospital profitability. Such knowledge may prepare policy-makers when setting future incentives/penalties for forthcoming changes that require extensive capital investments.

THEORY



According to our model (above), we illustrate the hypothesized relationship between MU dollars and profits for a hospital. As shown, the MU dollars have both a direct and indirect effect on profit. Directly, the MU dollars added money to the hospitals' budgets. However, the indirect effects occurred through quality improvements realized by capital investments to offset the significant expense of meaningful use of EHRs, thereby offsetting some loss of profits that would have occurred if the entire investment was the result of hospital dollars. Similarly, once the HIT capex were made, improvements in quality and efficiency performance were likely to impact the profits of hospitals. In this study, we specifically examine the area in the red to measure the indirect effects on HIT Capex.

METHODS

Data Sources

We combined multiple secondary data sources to form a panel of data for years 2010 – 2017. HIT-related capital expenditures came from the CMS Hospital Cost Report Information System (HCRIS) files "cost reports".[22] Cost reports are a widely-adopted source of hospital financial information because all hospitals are required to file these with CMS annually to receive Medicare reimbursement. While widely accepted, cost reports have been shown to report certain data inconsistently.[23] Still, the accessibility of financial data for all hospitals receiving CMS-based reimbursement makes cost reports a commonly accepted source of hospital financial data. MU data came from the CMS Eligible Hospital Recipients of Medicare EHR Incentive Program Payments.[24]

Study Design

We estimated the relationship between MU incentive dollars and HIT-related capital expenditures using maximum likelihood estimation. Hospital-years were included in the analysis if no missing values were present, using complete case analysis. Extreme values were Winsorized at the one percent tails of each variable's distribution [25,26]. Differences between the early period (2010 – 2013) and the latter period (2014 – 2017) were tested using Pearson's chi-square (categorical variables) and Wilcoxon rank test of medians (continuous variables). The threshold for statistical significance was set *a priori* at $p<0.05$. Standard errors were clustered at the hospital level.

Study Sample

The sample was limited to general acute care hospitals that received at least one MU incentive payment and reported at least one year of HIT-related capital expenditures during the sample period 2011 through 2017 (n=1,750). In 2010, CMS implemented a new cost report form. The 2010 cost report form made several material changes from the previous 1996 form. One of those changes was the addition of new data elements for capital expenditures and HIT-related capital expenditures. Because HIT-related capex was not reported on the cost report until the introduction of the 2010 form, it was necessary to begin our analysis with data from the newer 2010 cost report forms. We began by identifying 5,017 general acute care hospitals that reported cost reports during the sample period. Next, we limited our sample to only those hospitals for which CMS reported MU incentives/penalties (n=4,424). Then, we limited our sample to only hospitals that reported HIT-related capital expenditures, which reduced our sample reduced to 1,750 hospitals.

In unreported results, we determined there were statistically significant differences in our sample and the population of U.S. general acute care hospitals during the sample period. Compared to the population of U.S. hospitals, those in our sample were smaller, in terms of net patient revenue (NPR), received less MU incentive payments, less likely to be not-for-profits, and less likely to be CAHs. While the sample differed statistically from the population, the magnitude of those differences generally represented relatively small proportional differences. This may suggest that our sample was not extremely different than the U.S. population of hospitals. Nevertheless, the generalizability of our findings beyond our sample is limited and inferences to the broader population of U.S. hospitals should be done so with caution.

Study Variables

Dependent Variable

The key outcome measure was HIT-related capital expenditures, which we logged because of a skewed distribution. HIT-related capex has only been recorded on CMS cost reports since 2010, when CMS implemented a new cost report form. This measure came from Worksheet A7,

Part 1, row 7, Column 2. HIT-related capital expenditures should increase as new and continued investments in HIT occur.

Key Independent Variable

The key explanatory measure was the total MU incentive dollars received by hospital for the life of the MU incentive program, which was logged because of a skewed distribution. In Figure 1, the yellow highlighted box represents the specific program we investigated. This dollar amount included payments from all stages and across all years during which a hospital received any payment, as reported in the CMS Eligible Hospital Recipients of Medicare EHR Incentive Program Payments file. This measure was cumulative, not time-varying because, though EHR maintenance and optimization is capital-intensive, the upfront costs are generally much higher than maintenance. CITE. Since hospitals likely adopted based on long-term, strategic quality and financial estimates, the overall MU incentives (and penalties) were theorized to have a greater impact on HIT-capex than the annual flow of those funds.

Other Variables

Other factors evaluated in multivariable regression were operating margin, net patient revenue NPR, ownership type, and whether a hospital was a Critical Access Hospital (CAH). Operating margin controlled for profits directly related to day-to-day activities theoretically under the control of a hospital's management. NPR accounted for size and operating revenue directly tied to management's purview. Ownership was categorized as private for-profit, private not-for-profit, and government-owned, which controlled for differing financial objectives.[27] CAH status accounted for Medicare cost-based reimbursement and differences in MU incentive/penalty guidelines.[2]

Two additional variables were presented in Table 1 as descriptive statistics, total capex and total expenses, though they were not part of the theoretical design of the multivariable regression model due to suspected multicollinearity with the primary model specification. Some variables are presented in one form in the descriptive statistics (e.g., level, or scaled by 1,000), yet the same variable may have been transformed in the multivariable regression. One example is NPR, which was scaled by $1,000s in Table 1 but logged in Table 3 due to a skewed distribution.

RESULTS

Descriptive Statistics

In Table 1, we present descriptive statistics for hospitals in the sample. The first column depicts averages for all hospitals. In columns two and three, the averages for years 2010 – 2013

and 2014 – 2017 are presented, respectively. The sample was divided based on these years to compare spending in the earlier and later years of analysis. The last column shows the p-value for the appropriate test of statistical difference between years 2010 – 2013 and years 2014 - 2017.

The following results are unadjusted. The median annual HIT-related capital expenditures at hospitals in the sample was $352,000. Hospitals spent statistically more on HIT-capex in the earlier sample years than the later ($443,000 to $292,000, respectively). While HIT-capex was less in the latter sample years, total capex and total spending increased in the latter period for hospitals in the sample (total capex increased from $2.77mn to $2.84mn and total expenses increased from $48.65mn to $54.95mn). HIT-capex accounted for 14% of total capex in the earlier time period, but only 10% in the latter time period (unreported). While total capex increased in the latter period, it decreased as a proportion of total spending from 4.8% to 4.4% (unreported). These differences meant that HIT-capex accounted for 0.91% of total spending in the earlier years but only 0.53% of total spending in the latter years (unreported).

The median cumulative MU dollars received by hospitals in the sample was $3.01mn. NPR increased over time ($50.07mn to $55.93mn). Operating margin remained relatively stable across time periods, with a median of 1.83%. Hospitals in the sample were 54% not-for-profit owned, 22% for-profit, and 25% government. Sixty-two percent of hospitals in the sample were non-CAHs.

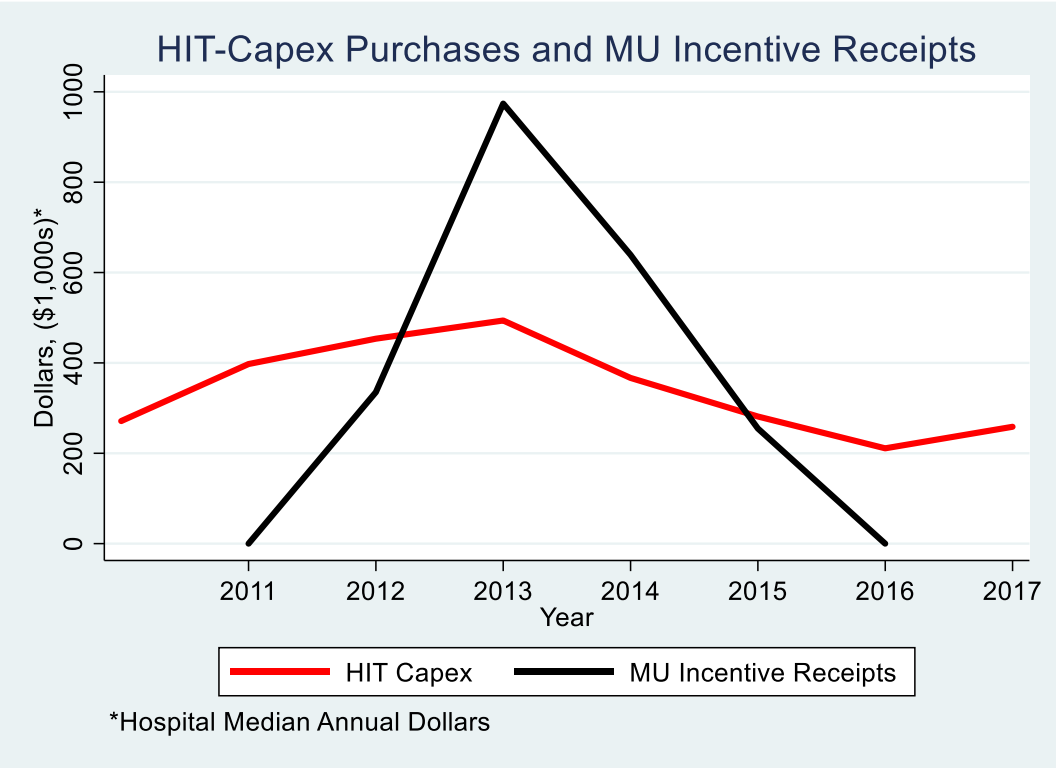
Table 1: Unadjusted Hospital Characteristics - Hospitals Receiving Any MU Incentive Receipts and Reporting HIT-Related Capex

	All Hospital Years	Years 2010 - 2013 (N= 6,962)	Years 2014 - 2017 (N= 6,890)	p
HIT-Related Capex ($1,000's)	352 (3,947)	443 (3,726)	292 (4,115)	<0.001***
Total Capex ($1,000's)	2,801 (30,500)	2,773 (30,300)	2,837 (30,700)	0.520
Total Expenses ($1,000's)	51,678 (286,806)	48,653 (253,877)	54,953 (316,160)	<0.001***
MU Receipts (Cumulative, $1,000's)	3,013 (2,234)			
Net Patient Revenue ($1,000's)	53,139 (208,419)	50,073 (197,378)	55,938 (218,700)	<0.001***
Operating Margin	1.83 (11.44)	1.86 (10.78)	1.80 (12.08)	0.53
Ownership (%)				
Not for Profit	54			
For Profit	22			
Government	25			
Critical Access Hospital (CAH) Status (%)				
Non - CAH	62			
CAH	38			
Averages are medians for continuous variables and means for binary / categorical variables. Standard deviation in parentheses.				
P-values by Wilcoxon rank test of medians for continuous variables and chi2 test for binary / categorical variables				
* p<0.05, ** p<0.01, *** p<0.001				

In Figure 2, we present median annual hospital-level HIT-related capital expenditures and MU incentive receipts in dollars, scaled by $1,000's. The red line represents HIT-related capex and the black line represents MU incentive receipts. In Table 1, we presented HIT-related capex by two groups of years (2010 – 2013 and years 2014 – 2017). In Figure 2, we present HIT-capex annually and show that HIT-capex increased until 2013 but then fell over time (p<0.001,

unreported). MU incentive receipts reflect the uptick in MU adherence nationally by hospitals through 2013, then a decrease in receipts through 2016. This pattern likely follows MU adherence by stages, where a greater proportion of MU incentive money was issued for Stage 1 adherence. Taken together, HIT-capex appears to have increased and then decreased during the same years as MU incentive receipts increased (2011 – 2013) and then decreased (2013 – 2016).

Figure 2: Hospital Median Annual HIT-Capex Purchases and MU Incentive Receipts



Regression Results

Bivariate regression-adjusted results describing the association between cumulative MU incentive receipts and HIT-related capital expenditures are presented in Table 2. Results from Table 2 show that hospitals receiving more MU incentive money spent larger amounts on HIT-related capex. A 10% increase in MU incentive receipts was associated with a 5.2% increase in HIT-related capex ($p<.001$). Roughly two-thirds of the error variance in the bivariate regression was due to between-cluster idiosyncratic variance rather than non-random within-cluster variance (unreported). This suggests that MU incentive receipts may explain a large amount of changes in HIT-related capex.

Table 2: The Association of Cumulative MU Incentive Receipts on HIT-Related Capital Expenditures

MU Receipts (Cumulative, logged)	.522***
	[.445,.599]
Constant	4.784***
	[3.655,5.911]

In Table 3, we present multivariable regression-adjusted results for factors associated with HIT-related capex. After controlling for other factors, MU receipts were positively associated with higher HIT-capex; a 10% increase in MU receipts was associated with an estimated 2.2% increase in HIT-capex ($p<.001$). Lower profitability, measured by operating margin, was associated with higher HIT-capex. Larger hospitals, measured by NPR, were associated with higher HIT-capex. Relative to not-for-profits, government hospitals spent more on HIT-capex. There was no statistical difference in spending between not-for-profits and for-profits. CAHs spent more on HIT-capex than non-CAHs. After controlling for other factors and compared to 2010, HIT-capex increased between 2011 and 2014, but slowed in 2016 and 2017. There was no statistically significant difference in spending between 2010 and 2015.

Table 3: Factors Associated with HIT-Related Capital Expenditures

MU Receipts (Cumulative, logged)	.220***	Year (Referent: 2010)	
	[.096,.343]	2011	.707***
Operating Margin	-.700*		[.358,1.056]
	[-1.355,-.046]	2012	.800***
Net Patient Revenue (logged)	.617***		[.453,1.138]
	[.518,.715	2013	.741***
Ownership (Referent: Not-for-Profit)			[.402,1.081]
For-Profit	0.208	2014	.593***
	[-.015,.430]		[.252,.934]
Government	.249*	2015	0.044
	[.030,.467]		[-.300,.388]
Critical Access Hospital (CAH) Status (Referent: Non-CAH)		2016	-.619***
CAH	.520***		[-.970,-.268]
	[.236,.804]	2017	-.749***
			[-1.109,-.389]
		Constant	-2.430*
			[-4.508,-.352]

DISCUSSION

Our main finding showed that MU incentives were positively correlated with HIT-related capex. The positive correlation between MU incentives and HIT-capex was relatively large – bivariable results suggested a 10% increase in MU incentive dollars was associated with 5.2% more HIT-capex (Table 2); multivariable results suggest the same 10% increase in MU dollars was

associated with 2.2% more HIT-capex (Table 3). As such, this suggests that hospitals that received MU incentive dollars reinvested the money into HIT to continue to improve the quality performance of the hospital.

The second most important finding was that HIT-capex at hospitals has decreased in recent years following the end of the MU program (Table 3). That decrease approximately followed the annual shift in MU incentive dollars (Figure 2). Our estimates in Tables 2 and 3 demonstrate the relative elasticity of hospital HIT-capital spending to shifts in MU incentives. Note multivariable regression suggested that elasticity may have had a lag effect because the point estimate in Table 3 suggested statistically higher spending through 2014, though Figure 2 showed a decrease in unadjusted spending in 2014. This finding supports Dranove et. al's earlier work suggesting MU incentives were associated with higher EHR adoption.[19] Our findings extend upon that work by suggesting MU incentives were associated with HIT-capex, and that association positively trended throughout the program.

Our third most important finding was that, after controlling for other factors, CAHs in our sample spent more on HIT-capex. That finding could be surprising, given that CAHs operated under different MU incentive guidelines that were in some ways more relaxed than non-CAHs.[2] However, some of this finding may be explained by the success of the Office of the National Coordinator for health Information Technology's 2011 deployment of technical assistance to rural providers through Regional Extension Centers (RECs). While prior work shows rural hospitals and CAHs were slower to adopt and continue re-attesting to MU, previous findings have also found that the RECs successfully improved EHR adoption.[28] It is possible that our finding reflects some of the success of the RECs. In unreported results, we found that CAHs spent a median of $196,000 on HIT-capex and non-CAHs spent $648,000. However, controlling for other relevant factors suggests that CAHs are investing more in HIT-capex than non-CAHs.

Our fourth most important finding was that there was no statistically significant difference in HIT-capex spending between not-for-profits and for-profits.

Our study has limitations. First, Medicare cost report data is known to report inconsistent results when compared to IRS 990 and audited financial statements.[26-28] Nevertheless, cost report data remains a prevalent source for hospital financial analytics. Second, accounting practices vary across hospitals, which could reflect variations in HIT-capex. One example may be differences in hospital-level decisions to purchase versus lease HIT-related capital equipment. Accounting practices may also differ across independent and system-affiliated hospitals, for which we could not distinguish. Fourth, our study only includes Medicare MU incentive payments for eligible hospitals. Though the data was not linked to other incentive forms and it is beyond the scope of this study, a follow-up study could consider the Medicaid Adopting, Implementing, or Upgrading (AIU) incentives, Medicaid and Medicare MU incentives to eligible providers, and Medicaid MU incentives to eligible hospitals (e.g., other programs displayed in Figure 1). Fifth, because the CMS did not require hospitals to differentiate whether capital spending was HIT-related until the 2010 Medicare Cost Report form change, we were not able to determine whether hospitals began spending more on HIT-related capital prior to MU passage (2009). Last, our sample accounted for approximately 40% of all U.S. hospitals, limiting the generalizability of our findings. This led us to carefully interpret our findings for hospitals within our sample – not all U.S. hospitals.

PRACTICE IMPLICATIONS

Our study advances knowledge of the relationship between incentive dollars allocated through a federal program and hospital-level capital spending in areas relevant to the intention of that policy. These findings are important for both policy-makers and hospital decision-makers. Our main finding that showed a positive correlation between MU incentives and HIT-related capex may provide some support for policy-makers evaluating the effectiveness of the MU incentive program to stimulate HIT-related capital investments at hospitals and offset some of those hospital costs.

Our second most important finding that demonstrated hospital executives increased and then decreased HIT-capital spending as the MU incentive dollars increased and then decreased led us to hypothesize two possible explanations. One, MU incentives effectively subsidized hospitals to invest appropriate amounts into HIT-related capex during the early years of EHR adoption, when upfront costs were expected to be substantial. Thus, hospital executives did not need to continue spending HIT-related capital at rates seen in prior years closer to the implementation of the MU program. Two, hospital executives were no longer able to continue spending on HIT-related purchases because MU incentives shrunk and ceased. In that case, hospital executives may not be reinvesting into HIT-related capital at rates needed to continue meaningful EHR performance necessary to meet the Medicare Promoting Interoperability Program requirements.[3] It is likely that these two potential explanations are not mutually exclusive.

Our third most important finding that, after controlling for other relevant factors, CAHs spent more on HIT-capex may suggest that MU incentive dollars could be especially meaningful for smaller hospitals with potentially fewer resources to invest in this area. Our fourth most important finding may suggest that differences in ownership between not-for-profit and for-profit hospitals did not lead to materially different strategies for HIT adoption by executives at those hospitals. The relatively higher HIT spending by government hospitals may be tied to other existing federal funding mechanisms that requires further investigation.

Now that we have determined a positive association between MU incentive dollars and HIT-capex, one next step will be to understand how that relationship impacts hospital profits. Given that the technology related to hospital care and quality has continued to evolve, it is unlikely that hospitals have already maximized quality performance related to HIT use.

CONCLUSIONS

Our findings suggest that MU incentives were positively correlated with HIT-related capex. Second, we showed that HIT-capex has decreased in recent years – both in total dollars and as a percent of total spending. Our findings may provide support for the efficacy of the MU incentive program to stimulate hospital EHR adoption. More work is needed to determine whether HIT-capex and the MU incentive program impacted hospital profitability.

LIST OF ABBREVIATIONS

CAH: Critical Access Hospital

Capex: capital expenditures

CMS: The Center for Medicare & Medicaid Services

EHR: Electronic Health Record

HCRIS: Hospital Cost Report Information System

HIT: Health Information Technology

MU: Meaningful Use

NPR: Net Patient Revenue

DECLARATIONS

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Availability of data and materials: Publicly-available data used for this research can be found in the hyperlinks provided in the References section.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: Each named author substantially contributed to the conception, design, and conducting the underlying research for this paper.

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