Health Information Exchange, Health Information Technology Use, and Hospital Readmission Rates

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ABSTRACT

The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 offers significant financial incentives to hospitals that can demonstrate "meaningful use" of EHRs. Reduced hospital readmissions are an expected outcome of improved care coordination. Increased use of HIT, and in particular participation in HIE are touted as ways to improve coordination of care. In a 2007 national sample of US hospitals, we evaluated the association between hospitals' HIE and HIT use and 30-day risk adjusted readmission rates for acute myocardial infarction (AMI), heart failure, and pneumonia. We found that hospital participation in HIE was not associated with lower hospital readmission rates; however, high levels of electronic documentation (an aspect of HIT use) were associated with modest reductions in readmission for heart failure (24.6% vs. 24.1%, P=.02) and pneumonia (18.4% vs. 17.9%, P=.003). More detailed data on participation in HIE are necessary to conduct more robust assessment of the relationship between HIE and hospital readmission rates.

INTRODUCTION

The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 authorizes the Centers for Medicare and Medicaid Services (CMS) to pay up to an estimated $27 billion dollars in incentives to promote adoption and "meaningful use" of "certified" electronic health records (EHRs).[1] A sizeable portion of these payments will be made to hospitals meeting "meaningful use" requirements.[2,3] Participation in health information exchange (HIE), i.e., electronically exchanging key clinical information such as discharge summaries, procedures, problem lists, medication lists, medication allergies, and diagnostic test results with other external healthcare providers is a core requirement of Stage 1 "meaningful use" for hospitals. In addition the Stage 1 criteria include several utilization thresholds that must be cleared in order to qualify for the incentive payments (e.g., > 30% inpatients have at least one medication order entered using CPOE). These thresholds will be progressively raised and new requirements will be added in the Stages 2 and 3.[4]

Poor communication between providers in the hospital as well as between hospital based providers and primary care providers in the community is a common problem that leads to poor care coordination and may result in low quality or inefficient patient care.[5,6] An expectation implicit in the HITECH legislation is that increased participation in HIE and increased use of HIT will lead to improved coordination of care and in turn improved quality and efficency.[7,8] However there is little quantitative evidence of the effects of HIE on hospital quality and efficiency.[9] On the other hand, many studies have evaluated the effects of HIT on hospital quality and efficiency, but these studies have produced mixed results.[10-13] Systematic reviews of this literature have concluded that many HIT studies are of limited generalizability.[9,14] In addition, extant studies' utility for estimating the effects of "meaningful use" is limited because they have typically focused on the presence or absence of HIT without assessing how frequently or for what tasks HIT was used.[10-13]

Our analysis focused on evaluating, in a large sample of U.S hospitals, the association between two components of "meaningful use" (participation in HIE, and the *use of* HIT) and risk adjusted thirty-day hospital readmission rates. Focusing on participation in HIE allows us to fill an important gap in the literature, and focusing on the actual *use of* HIT, rather than on the implementation status alone should better inform expectations about the potential effects of the "meaningful use" programs on hospital readmission rates.

METHODS

Study Design and Data Sources

We conducted a retrospective cross-sectional analysis of the association between risk-standardized thirty-day hospital readmission rates, hospital participation in HIE and reported frequency of the use of HIT to carry out three important clinical tasks (medication ordering, laboratory ordering, and clinical documentation) in a large sample of U.S. hospitals. Data on hospital characteristics were obtained from the 2007 American Hospital Association (AHA) Annual Survey Database.[15] The 2007 AHA survey also included an information technology (IT) supplement. The IT supplement consisted of questions about the implementation status of a variety of health information technologies and the frequency of use of some clinical applications. We limited our analyses to general acute care non- federally owned U.S. hospitals. Readmission data were obtained from the September 2009 release of the Hospital Compare database. The Hospital Compare database is a product of the Centers for Medicare and Medicaid Services (CMS) Hospital Inpatient Quality Reporting Program. The Hospital Compare database included

risk-standardized 30-day readmission rates for Medicare beneficiaries admitted with acute myocardial infarction (AMI), heart failure, and pneumonia for the period June 2005 to June 2008.[14] Of the 6,312 hospitals included in the 2007 AHA annual survey database, 4,644 met our inclusion criteria. Of these eligible hospitals, 4,125 participated in CMS' Hospital Inpatient Quality Reporting Program. Of the remaining hospitals, 2,406 (58%) responded to the AHA IT survey.

Measure of HIE Participation

The AHA IT survey asks hospitals to report whether they exchange patient demographics, clinical care records, laboratory results, medication lists, radiology reports, or discharge summaries with ambulatory providers outside of their hospital system. Hospitals that reported electronically exchanging any of the aforementioned patient data with ambulatory providers outside of their hospital system were coded as participants in HIE.

Measures of HIT *Use*

The AHA IT survey asks hospitals to self report the portion of inpatients for which medication orders, lab orders, and clinical documentation were done electronically. Hospitals had the option of choosing one of five ranges of values (0%, 1-25%, 26%-50%, 51-90%, 91-100%). In addition to participation in HIE, Hospitals' self-reported level HIT use served as predictors of interest for our analyses. Frequency of use is more likely to be an accurate measure of adoption than a binary measure of implementation status because even amongst hospitals where HIT is implemented usage rates can be highly variable.[17]

Outcome Measures

The unit of analysis was the hospital, and outcomes of interest were all-cause thirty-day risk-standardized readmission rates for patients initially admitted with a principal diagnosis of acute myocardial infarction (AMI), heart failure, and pneumonia. The denominator for the readmission measures was live-discharged Medicare Fee-for-Service patients, age 65 and up, with a principal diagnosis of AMI, heart failure, or pneumonia. These conditions are common among Medicare beneficiaries, and there is considerable variation in readmission rates for these conditions across U.S. hospitals.[18]

Statistical Analysis

Initially we estimated unadjusted differences in the mean 30-day risk standardized readmission rates across the different levels of HIE participation and HIT use via analysis of variance. Next, we used a propensity score method to account for potential biases arising from nonrandom allocation of hospitals into the 'treatment levels", i.e., whether or not the hospital participated in HIE. Typical of the method, these analyses were carried out in two stages.[17] To

assign propensity scores, in the first-stage we calculated the conditional probability of participating in HIE. Propensity scores were estimated via a multivariable logistic regression model where the a binary indicator of HIE participation was regressed on a set of hospital characteristics (ownership, critical access status, trauma status, number of beds, teaching status, system membership, core-based statistical area type, U.S. census division, presence of a long term care unit, and the presence of a coronary care unit). The selection of these characteristics was based on our review of literature identifying hospital characteristics that are associated with the HIT adoption.[20] Covariate balance for the propensity score model was assessed via multivariable logistic regression.

Once covariate balance was determined, the propensity scores were included as covariates in a second-stage linear regression model. The second-stage model regressed 30-day risk-standardized mortality rates on the propensity score, HIE participation, level of electronic medication ordering, level of electronic laboratory ordering, and level of electronic documentation. Standard methods for controlling the false discovery rate were used to a correct for multiple hypothesis tests.[21] All P values presented hereafter are corrected for the false discovery rate, and this corrected P value $< .05$ was assumed to be the threshold for statistical significance. All statistical analyses were performed using SAS version 9.2. SAS (SAS Institute, Cary, North Carolina).

RESULTS

The majority of hospitals in our sample did not participate in HIE (58.7%), did not order medications electronically (60.4%), nor did the majority report ordering labs electronically (50.9%). On the other hand, a slight majority of hospitals reported some use of electronic clinical documentation (51.7%, See Table 1). Table 2 shows unadjusted and adjusted readmission rates for AMI, heart failure, and pneumonia stratified by hospital's participation in HIE. Unadjusted comparisons indicate that HIE participation was associated with significantly lower heart failure readmission (24.3% vs. 24.6%, P=.003); however adjusted analyses indicate no statistically significant associations between HIE participation and hospital readmission rates. Tables 3-5 show the unadjusted and adjusted readmission rates for AMI, heart failure, and pneumonia stratified by hospital's level of electronic medication ordering (Table 3), level of electronic laboratory ordering (Table 4), and level of electronic documentation (Table 5). In adjusted analyses, no level of electronic medication ordering or electronic laboratory ordering was associated with lower hospital readmission rates. However, having high levels (i.e., 91-100%) of inpatients having electronic documentation was associated with modest reductions in adjusted

readmission rates for heart failure (24.6% vs. 24.1%, P=.02) and pneumonia (18.4% vs. 17.9%, P=.003).

Table 1. Study Sample Participation in HIE and Use of HIT	
Participated in HIE	**% of Study Sample N = 2406**
Yes	41.3
% of Inpatients with Electronic Medication Orders	
0%	60.4
1-25%	12.8
26-50%	4.5
51-90%	6.7
91-100%	15.6
% of Inpatients with Electronic Laboratory Orders	
0%	50.9
1-25%	10.2
26-50%	4.4
51-90%	8
91-100%	26.4
% of Inpatients with Electronic Documentation	
0%	48.3
1-25%	20.2
26-50%	7.9
51-90%	11.8
91-100%	11.8

Table 2. Unadjusted and Adjusted Readmission Rates by % of Participation in Health Information Exchange

Condition	**Health Information Exchange Participant**	**Unadjusted Readmission Rate (%)**	***P Value (Relative to Reference)***	**Adjusted Readmission Rate (%)**	***P Value (Relative to Reference)***
AMI	**No**	20.0	*Ref*	19.9	*Ref*
	Yes	19.8	0.14	19.8	0.18
Heart Failure	**No**	24.6	*Ref*	24.4	*Ref*
	Yes	24.3	0.003	24.2	0.11
Pneumonia	**No**	18.2	*Ref*	18.2	*Ref*
	Yes	18.1	0.68	18.1	0.68

Table 3. Unadjusted and Adjusted Readmission Rates by % of Patients with Electronic Medication Orders					
Condition	**% of Inpatients with Electronic Medication Orders**	**Unadjusted Readmission Rate (%)**	***P* Value (Relative to Reference)**	**Adjusted Readmission Rate (%)**	***P* Value (Relative to Reference)**
AMI	**0%**	19.9	*Ref*	19.9	*Ref*
	1-25%	19.7	0.65	19.6	0.17
	26-50%	19.7	0.91	19.8	0.83
	51-90%	20.0	0.43	19.9	0.98
	91-100%	20.0	0.14	19.9	0.91
Heart Failure	**0%**	24.5	*Ref*	24.3	*Ref*
	1-25%	24.3	0.35	24.2	0.86
	26-50%	24.4	0.86	24.5	0.44
	51-90%	24.4	0.72	24.3	0.86
	91-100%	24.6	0.27	24.4	0.58
Pneumonia	**0%**	18.1	*Ref*	18.1	*Ref*
	1-25%	18.0	0.07	17.9	0.60
	26-50%	18.3	0.88	18.3	0.60
	51-90%	18.1	0.60	18.1	0.88
	91-100%	18.4	0.41	18.4	0.16

Table 4. Unadjusted and Adjusted Readmission Rates by % of Patients with Electronic Laboratory Orders					
Condition	**% of Inpatients with Electronic Laboratory Orders**	**Unadjusted Readmission Rate (%)**	***P* Value (Relative to Reference)**	**Adjusted Readmission Rate (%)**	***P* Value (Relative to Reference)**
AMI	**0%**	19.9	*Ref*	19.7	*Ref*
	1-25%	19.7	0.29	19.9	0.44
	26-50%	19.7	0.30	19.6	0.83
	51-90%	19.9	0.88	19.9	0.44
	91-100%	20.0	0.29	20.0	0.14
Heart Failure	**0%**	24.4	*Ref*	24.3	*Ref*
	1-25%	24.3	0.35	24.4	0.62
	26-50%	24.0	0.15	23.9	0.86
	51-90%	24.5	0.86	24.5	0.86
	91-100%	24.6	0.14	24.6	0.41
Pneumonia	**0%**	18.1	*Ref*	18.1	*Ref*

	1-25%	18.1	0.70	18.2	0.60
	26-50%	18.2	0.68	18.1	0.60
	51-90%	18.1	0.88	18.1	0.88
	91-100%	18.3	0.13	18.2	0.16

Table 5. Unadjusted and Adjusted Readmission Rates by % of Patients with Electronic Clinical Documentation

Condition	% of Inpatients with Electronic Clinical Documentation	Unadjusted Readmission Rate (%)	*P* Value (Relative to Reference)	Adjusted Readmission Rate (%)	*P* Value (Relative to Reference)
	0%	20.0	*Ref*	20	*Ref*
	1-25%	19.8	0.17	19.8	0.29
	26-50%	19.9	0.73	19.9	0.73
	51-90%	19.8	0.17	19.7	0.14
AMI	**91-100%**	19.8	0.17	19.7	0.14
	0%	24.6	*Ref*	24.6	*Ref*
	1-25%	24.4	0.14	24.4	0.27
	26-50%	24.2	0.09	24.2	0.12
Heart	**51-90%**	24.4	0.27	24.4	0.25
Failure	**91-100%**	24.3	0.1	24.1	0.02
	0%	18.3	*Ref*	18.4	*Ref*
	1-25%	18.1	0.41	18.2	0.26
	26-50%	18.1	0.6	18.2	0.41
	51-90%	18.1	0.6	18.1	0.24
Pneumonia	**91-100%**	18.0	0.11	17.9	0.003

DISCUSSION

We did not find a significant relationship between participation in HIE and hospital readmission rates. On the other hand we found that increased *use* of Health IT for clinical documentation was associated with modestly lower readmission rates. Our results suggest that on average readmission rates for heart failure and pneumonia were lower in hospitals where clinical documentation for most patients (i.e., 91-100%) was done electronically.

Reduced preventable hospital readmissions are an expected outcome of improved care coordination. Increased use of HIT and in particular participation in HIE are touted as ways to improve coordination of care.[7,8] No prior studies have empirically evaluated the relationship between HIE participation and hospital readmission rates. To our knowledge, ours is the first study to examine the relationship between HIE participation and hospital readmission rates. The evidence relating HIT *use* to hospital readmission rates (without reference to HIE) is similarly limited. Our review of the literature identified only one study that sought to estimate the relationship between HIT and hospital readmission rates, a recent study by DesRoches and colleagues, which found no significant associations between HIT adoption and hospital readmission rates.[13] While we used data sources and outcomes similar to DesRoches et al; our analytical approach was distinct in that we focused on the frequency of HIT *use* rather than the presence or absence of HIT. We believe that this analytical approach is more consistent with the current programs to stimulate "meaningful use"; and therefore our results are likely to be somewhat more indicative of the results of programs designed to stimulate increased use of HIT.

Our study has limitations. Although we employed statistical techniques to control for observable factors that may confound the relationship between HIE participation, HIT use, and hospital readmission rates, as in any observational cross-sectional study our analyses remain vulnerable to the possibility of unmeasured confounding factors. We evaluated readmission rates for only three conditions among Medicare beneficiaries; HIE participation and HIT use could have different effects on readmission rates for other medical conditions and other patient populations. Finally, there are two important potential sources of error in the study data on HIE and HIT use: we relied on self-reported participation in HIE and rates of HIT use (which may have been inaccurate), and our HIE measure did not specify exactly what health information was being exchanged and with whom. Error in these independent variables would be expected to bias study findings towards the null hypothesis.

Our analysis has implications for the perception and expectations of the current "meaningful use" criteria, and for the development of the criteria for Stages 2 and 3. The current Stage 1 "meaningful use" regulations only require hospitals to test their capacity to exchange clinical information with external providers, while the proposed criteria for Stages 2 and 3 set minimum thresholds for the number of external providers that hospitals will be required to exchange information with.[4] We did not find significant reductions in readmission rates for hospitals that reported participating in HIE. However; our measure of HIE participation did not allow us to determine to what extent hospitals were exchanging information with associated ambulatory physicians. Having more detailed data to describe health information exchanges (such as the specific types of data exchanged and the providers who participate in the exchange) would certainly facilitate more robust assessments of the relationship between hospital readmission rates and HIE. Finally, we also found that high levels of electronic documentation were associated with lower readmission rates. While Stage 1 does not include any requirements for electronic documentation; tentatively Stages 2 and 3 will require that 30% and 80% of inpatients have electronic clinical notes.[4] Our results suggest that higher levels of use (i.e., 91-100% of inpatients) may be necessary in order to have an effect on hospital readmission rates.

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