Leveraging Electronic Health Records to Improve Hospital Performance: The Role of Management

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DETAILED ABSTRACT

Background and Motivation

An ambitious policy effort is underway to promote adoption of electronic health records (EHRs) in every hospital across the nation. Under the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act, hospitals that implement EHRs and demonstrate that they meet federally-defined meaningful use criteria are eligible for incentive payments.(1, 2) The motivation for HITECH was widespread agreement that the use of EHRs would result in substantial performance improvement. Easier access to patient medical records could enable physicians to make better clinical decisions and more effectively coordinate care; computerized provider order entry could avoid unsafe medications and the associated cost of adverse events; and laboratory and radiology result viewing could decrease the likelihood of duplicative testing. However, evidence to-date has failed to find a consistent relationship between EHR adoption and improved hospital performance(3-6), suggesting that the average effect may be close to zero. While this may be true, there are well-documented case studies in which EHRs have been leveraged to produce substantial gains in quality and efficiency.(7-9) We do not yet understand the conditions under which EHRs lead to improved hospital performance.

An important organizational dimension shown to facilitate IT-enabled performance improvement in other industries, such as retail and banking, is the degree to which the organization is generally well managed. Differences in management practices explain productivity differentials across companies, and could be particularly critical to realizing gains from IT. The intuition is that IT is a tool that influences performance based largely on how it is used. Unless there is a concerted and thoughtful approach to managing how IT is used to improve performance, it will not achieve the potential quality and efficiency gains, and may even be disruptive in ways that cause productivity losses. These hypotheses have growing empirical support. For example, Bloom, Sadun, and Van Reenan find that the strength of human capital management practices appears to be drive productivity gains from IT.(10) On the other end of the spectrum, in poorly managed organizations, Hitt, Wu and Xiaoge find that IT can result in productivity losses by adding technological complexity that the organization may not be equipped to address.(11)

We do not yet know whether the same phenomena apply to hospitals because, until recently, we have lacked nationally representative data on the quality of hospital management. We have therefore been unable to assess whether the quality of hospital management is the missing link that explains when EHR adoption results in performance improvement. In this paper, we leverage a unique data set on hospital management practices that was collected through interviews with managers in a nationally representative random sample of acute-care hospitals in order to explore whether management quality modifies the relationship between EHR adoption and cost and quality outcomes. We focus on outcomes related to acute myocardial infarction (AMI) because management survey respondents were predominantly from cardiology units.

Methods

Data, Measures, and Sample

Our study leverages four sources of data. To determine whether a hospital had an electronic health record, we use the 2009 American Hospital Association (AHA) IT supplement that is administered to all AHA member hospitals.(12) We determined which hospitals had at least a basic EHR, defined by Jha et al. 2009 as a system that includes ten specific functionalities, such as computerized provider order entry for medications, test result viewing, problem lists, and medication lists.(13) We leverage the broader AHA Annual Survey to capture data on key hospital characteristics – size (<100 beds, 100-399 beds, >400 beds), teaching status (major teaching, minor teaching, non-teaching), ownership (private, for-profit; private, not-for-profit; public), urban/rural, percent of Medicare discharges, and system affiliation.

Management practices were measured using a team of trained analysts who conducted interviews with unit or departmental managers in cardiology or orthopedics units in a random sample of 325 AHA-member acute care hospitals.[1] The interviews covered management practices across three broad areas:

- Operations management. How standardized are main clinical procedures and how well is the clinical staff trained in these protocols?

[1] We confirmed that the sample was nationally representative along an array of hospital characteristics (teaching status, size, urban/rural, system membership, percentage of Medicare discharges, percentage of Medicaid discharges, ownership, and nurse staffing ratios).

- Performance and target management. How does the hospital set and track its main goals? How are these indicators reviewed? What are the consequences for failing to meet targets?

- People management. What systems are in place to recruit hospital staff? Does the hospital evaluate employees and reward based on performance? Is there an active promotion system that strives to maintain and incentivize employees?

To obtain accurate and unbiased responses, the analysts conducting the interviews with hospital managers were "double blind". This means that both (1) managers are unaware of the scoring methodology and the criteria they are being scored against, and (2) interviewers are unaware of the hospitals' performance or other distinguishing features of the organization in which they are conducting interviews. The tool applied definitions and scores from one ("worst practice") to five ("best practice") along 20 dimensions across the three areas listed above, with an average of the 20 scores serving as the overall management practice measure. In other words, a score of 5 suggests that the unit has excellent management practices. Appendix Table 1 reports sample questions and a link to the complete instrument. Bloom and Van Reenen (2007) present extensive tests of the reliability of these management measures and their robustness to many different forms of psychological bias.(14)

To capture both cost and quality performance, we examined three measures of hospital performance: length-of-stay (LOS), 30-day risk adjusted mortality, and payment per discharge. All measures were generated from 2009 Medicare data for beneficiaries hospitalized for acute myocardial infarction (AMI). We chose to focus on AMI outcomes because we were concerned that there might be substantial unit-to-unit variation in both management and outcomes within hospitals. Since the majority of respondents represented cardiology units, we felt that AMI-focused outcomes would be the most reliable indicators of the impact of management on EHR effectiveness.

Our analytic sample is the 203 U.S. acute-care hospitals that were included in the random sample of AHA hospitals used to collect management data and that responded to AHA IT supplement. Since not all hospitals also had outcomes data available, our models include between 127 and 191 hospitals, depending on the outcome used.

Analytic Approach

To assess whether management modifies the relationship between EHR adoption and hospital performance, we estimate an ordinary least squares regression in which we predict (a) average length-of-stay for AMI discharges, (b) 30-day risk adjusted AMI mortality rate, or (c) average payment for AMI discharges. Our focal predictors are the hospital's management score (range of 1-5) and whether or not the hospital had adopted at least a basic EHR. We include a set of control variables that may confound the relationship between management, EHR adoption, and outcomes: size, teaching status, ownership, rural/urban, percent Medicare admissions, and whether the hospital is affiliated with a system. We use weights to adjust for potential nonresponse bias due to known differences between respondents and non-respondents to the AHA IT supplement. To assess whether management moderates the impact of EHR adoption on various outcomes, we include a term that interacts management with EHR adoption. We also calculate marginal effects across the range of management scores in increments of 0.5 (approximately equal to the standard deviation of 0.56 in our sample) in order to compare predicted outcomes for hospitals with and without EHRs.

Key Results

- Table 1 reports summary statistics. 11% of hospitals in our sample had adopted at least a basic electronic health record. The average management score of 2.98 (SD=0.56; range 1.4-4.3) was effectively at the mid-point of the 1-5 scale. For our outcomes of interest, mean LOS for patients hospitalized for AMI was 5.33 days (SD=1.55; range 1.08-9.95). The 30-day risk-adjusted mortality rate was 19% (SD=17%, range 0%-100%). Average payment per discharge was $9,071 (SD=$5,533, range $787-$28,133).
- In our baseline models, we fail to find evidence that EHR adoption is associated with improved performance on any of our three outcomes (Models 1, 3, and 5; Table 2) However, we find that management modifies the relationship between EHR adoption and two outcomes in the predicted direction: length-of-stay and payment. (Models 2 and 6; Table 2) We find no evidence of effect modification for mortality. (Model 4; Table 2)
- The modified effects are depicted in Figures 1-3, which graph the average predicted outcome across the full range of management scores, for hospitals with EHRs and those without EHRs.

- To help interpret the magnitude of effect, we predicted length-of-stay and payment for hospitals with and without EHRs at two levels of management – relatively poor management (a score of 2) and relatively strong management (score of 4). For length-of-stay, in a hospital that is not well managed, hospitals with EHRs have a predicted LOS of 6.4 days compared to 5.0 days in hospitals without an EHR (21% higher). In contrast, in well managed hospitals, those with EHRs have a predicted LOS of 4.5 days compared to 5.5 days in hospitals without EHRs (24% lower).
- Similarly, for payment, in a hospital that is not well managed, hospitals with EHRs have a predicted payment per discharge of $13,116 compared to $7,611 in hospitals without an EHR (42% higher). In well managed hospitals, those with EHRs have a predicted payment of $7,657 compared to $10,301 in hospitals without EHRs (35% lower).

Discussion and Implications

- We found that, overall, EHRs do not seem to have a beneficial or harmful effect on efficiency or quality. This is consistent with the broader literature on EHR effectiveness that has failed to find a consistent relationship between EHRs and hospital performance.
- However, the impact of EHRs, at least on measures of efficiency, appears to be modified by the quality of management in the hospital. Specifically:
    - When hospitals are poorly managed, EHRs are associated with worse efficiency.
    - When hospitals are well managed, having an EHR is associated with better efficiency.
- These findings suggest that management serves as an important factor than enables EHRs to improve hospital productivity.
- In order to gain more insight into what dimension of management may be particularly helpful in enabling EHRs to be effective, we plan to investigate the three dimensions of management (operations management, performance and target management, people management) to determine if a particular dimension is driving the modification effect we observe. This will allow us to better develop hypotheses about the mechanisms through which management may have the greatest impact on improving care efficiency in the context of broad EHR adoption.

- This paper is among the first to explain the lack of consistent relationship between EHRs and hospital performance. An understanding of why some hospitals are successful in realizing efficiency gains from their EHR while others are not will help ensure that our large national investment in EHRs translates into real productivity gains for our healthcare system.
- These findings are also timely given current federal investments to promote EHR adoption along with movement towards implementation of the Affordable Care Act, including a variety of delivery reforms which are likely to focus attention on management strategies.

Table 1. Summary Statistics

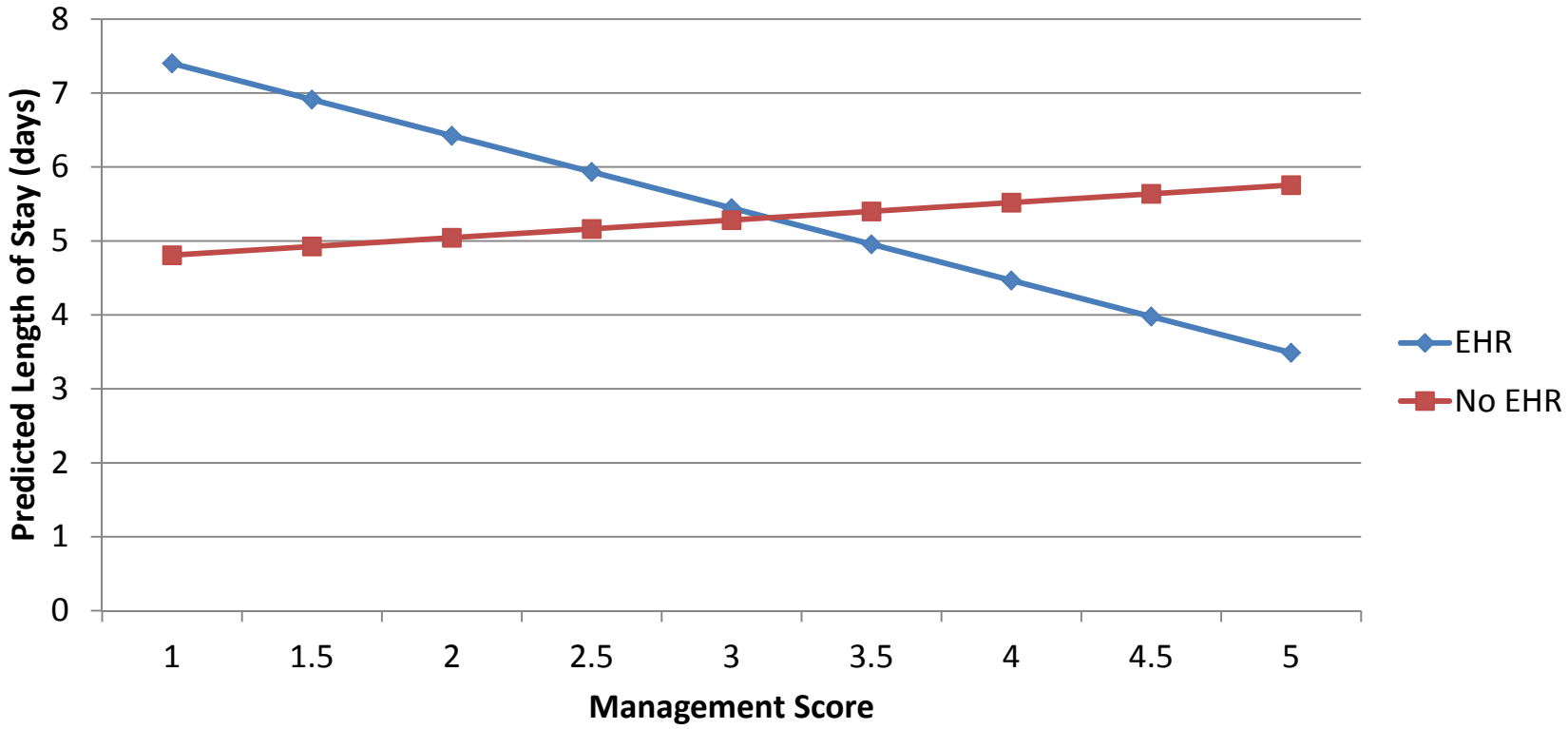
		N	Mean	Std. Dev.	Min	Max
AMI OUTCOMES	Length of Stay (days)	127	5.33	1.55	1.08	9.95
	30-day Risk Adjusted Mortality	191	0.19	0.17	0.00	1.03
	Payment per Discharge ($)	190	9,070.87	5,532.91	787.00	28,133.33
FOCAL PREDICTORS	Basic Electronic Health Record	203	0.11	0.31	0.00	1.00
	Management Composite Score (1-5)	203	2.98	0.56	1.40	4.30
TEACHING	Major Teaching	203	0.05	0.23	0.00	1.00
	Minor Teaching	203	0.25	0.43	0.00	1.00
	Non-Teaching	203	0.70	0.46	0.00	1.00
OWNERSHIP	Public	203	0.29	0.45	0.00	1.00
	Private, For Profit	203	0.07	0.26	0.00	1.00
	Private, Not-for-Profit	203	0.64	0.48	0.00	1.00
SIZE	Small (<100 beds)	203	0.49	0.50	0.00	1.00
	Medium (100-399 beds)	203	0.40	0.49	0.00	1.00
	Large (>400 beds)	203	0.10	0.31	0.00	1.00
OTHER	Percent Medicare Admissions	203	0.50	0.13	0.11	0.86
	Urban	203	0.50	0.50	0.00	1.00
	System Affiliated	203	0.49	0.50	0.00	1.00

Table 2. Ordinary Least Squares Regression Results Predicting AMI Outcomes: Hospital Management and EHR Adoption

OUTCOME:	LENGTH OF STAY		30-DAY MORTALITY		PAYMENT	
	Base	Interaction	Base	Interaction	Base	Interaction
MODEL:	(1)	(2)	(3)	(4)	(5)	(6)
EHR	-0.223	3.783	0.03	0.191	164.84	12,838.89***
	[0.458]	[2.540]	[0.048]	[0.204]	[1,105.81]	[3,981.23]
MANAGEMENT	0.005	0.237	-0.045	-0.035	576.90	1,344.62**
	[0.258]	[0.266]	[0.034]	[0.041]	[585.04]	[559.71]
EHR X MANAGEMENT		**-1.215***		**-0.052**		**-4,074.24*** **
		[0.711]		**[0.058]**		**[1,279.88]**
No Teaching	Reference	Reference	Reference	Reference	Reference	Reference
Major Teaching	0.569	0.479	0.022	0.018	3,081.03**	2,786.74**
	[0.351]	[0.364]	[0.030]	[0.030]	[1,320.64]	[1,273.16]
Minor Teaching	0.318	0.301	0.041**	0.036**	1,403.71	1,019.21
	[0.327]	[0.329]	[0.018]	[0.018]	[1,048.99]	[992.54]
Not-for-Profit	Reference	Reference	Reference	Reference	Reference	Reference
Public	-0.691**	-0.636*	0.007	0.011	132.36	377.89
	[0.325]	[0.323]	[0.033]	[0.033]	[855.15]	[848.78]
For Profit	0.766	0.8	0.011	0.014	1,568.69	1,843.16
	[0.640]	[0.617]	[0.041]	[0.040]	[1,596.89]	[1,568.04]
Small (1-99 beds)	Reference	Reference	Reference	Reference	Reference	Reference
Medium (100-399 beds)	0.876**	0.951**	-0.069***	-0.065**	3,537.54***	3,856.91***
	[0.417]	[0.421]	[0.026]	[0.026]	[829.39]	[837.80]
Large (400+ beds)	2.249***	2.267***	-0.04	-0.039	5,926.65***	6,004.69***
	[0.492]	[0.496]	[0.035]	[0.034]	[1,187.98]	[1,202.41]
Proportion of Medicare Admissions	1.354	1.406	0.038	0.042	-7,585.92***	-7,176.66***
	[1.335]	[1.343]	[0.123]	[0.124]	[2,614.85]	[2,584.02]
Urban	0.311	0.289	-0.052*	-0.051*	2,030.40***	2,100.75***
	[0.334]	[0.331]	[0.030]	[0.030]	[638.29]	[643.14]
System Affiliated	0.138	0.093	0.023	0.02	961.62	746.61
	[0.257]	[0.258]	[0.028]	[0.027]	[626.98]	[619.04]

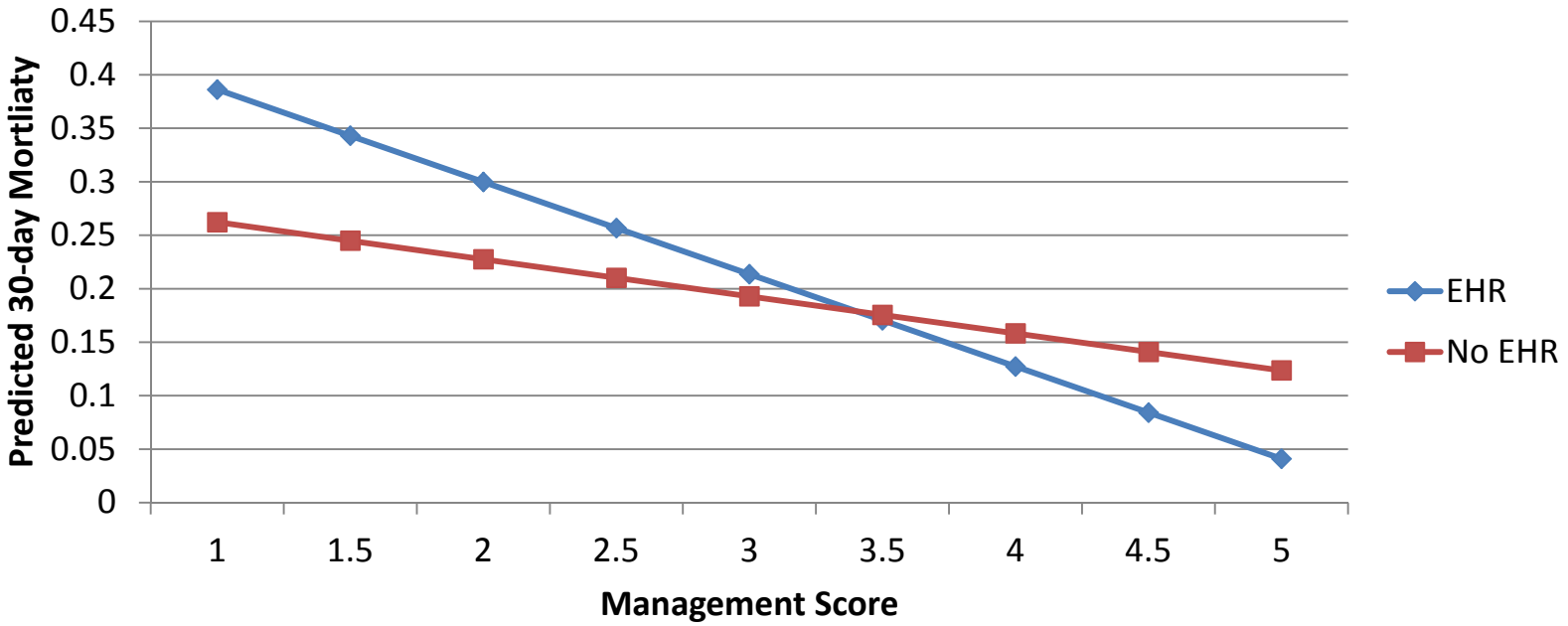
This table reports coefficients from OLS regressions. Brackets contain robust standard errors; *** p<0.001, ** p<0.01, * p<0.05

Figure 1. Relationship between Management and AMI Length of Stay among Hospitals with and without an Electronic Health Record



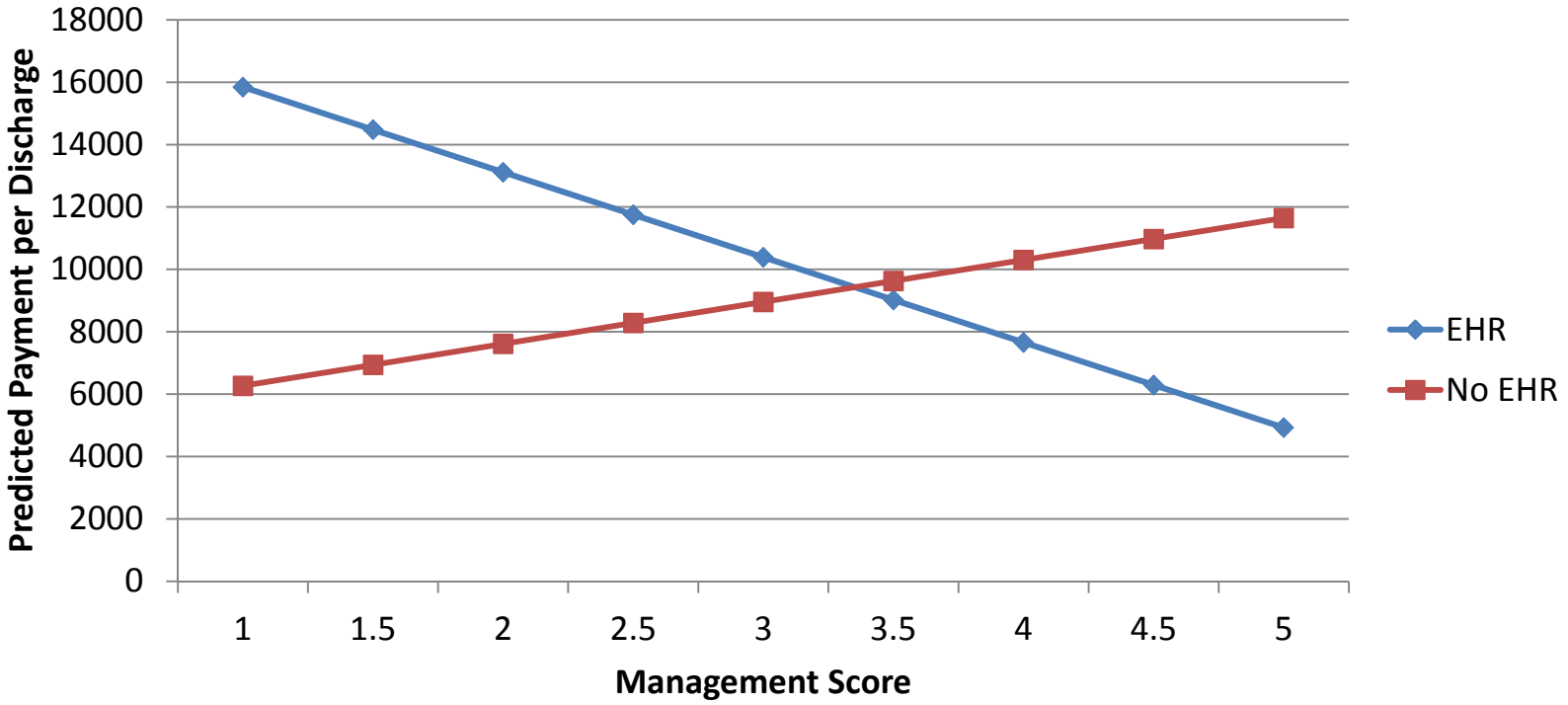
This figure displays the average predicted length of stay for AMI patients based on results of Model 2 in Table 2. Management score ranges from 1 to 5, with 1 reflecting weak management practices and 5 representing strong management practices.

Figure 2. Relationship between Management and 30-day Risk Adjusted AMI Mortality among Hospitals with and without an Electronic Health Record



This figure displays the average predicted 30-day mortality for AMI patients based on results of Model 4 in Table 2. Management score ranges from 1 to 5, with 1 reflecting weak management practices and 5 representing strong management practices.

Figure 3. Relationship between Management and AMI Payment among Hospitals with and without an Electronic Health Record



This figure displays the average predicted payment per discharge for AMI patients based on results of Model 6 in Table 2. Management score ranges from 1 to 5, with 1 reflecting weak management practices and 5 representing strong management practices.

Appendix Table 1. World Management Survey – U.S. Hospital Dimensions and Scoring Example: Operations component

Operations Management is about how effectively the patient journey and pathway management is configured: what is the motivation behind changes to operations, how standardized and integrated are clinical pathways, and are staff deployed to do what they are best qualified for?				
1. Layout of patient flow	*In regards to the patient journey or flow for a typical episode, how closely located are wards, theatres, diagnostics centres and consumables? How often do you run into problems with the current pathway management?*			
Score 1	Score 2	Score 3	Score 4	Score 5
Lay-out of hospital and organisation of workplace is not conducive to patient flow (e.g. ward is on different level from theatre or consumables are often not available in the right place at the right time).	Between 1 and 3	Lay-out of hospital has been thought-through and optimised as far as possible; work place organisation is not regularly challenged/ changed (or vice versa).	Between 3 and 5	Hospital layout has been configured to optimize patient flow; workplace organization is challenged regularly and changed whenever needed.
2. Rationale for introducing standardization/pathway management	*What is the rationale for making operational improvements to the management of the patient pathway?*			
Score 1	Score 2	Score 3	Score 4	Score 5
Changes were imposed topdown or because other departments were making (similar) changes; rationale was not communicated or understood.	Between 1 and 3	Changes were made because of financial pressure and the need to save money or as a (short-term) measure to achieve government and/ or external targets.	Between 3 and 5	Changes were made to improve overall performance, both clinical and financial, with buy-in from all affected staff groups; the changes were communicated in a coherent 'change story'.
3. Standardisation and protocols	*How standardized are the main clinical processes?*			
Score 1	Score 2	Score 3	Score 4	Score 5
Little standardisation and few protocols exists (e.g. different clinical staff have different approaches to the same treatments).	Between 1 and 3	Protocols have been created but are not commonly used because they are too complicated or not monitored adequately (e.g. may be on website or in manual only).	Between 3 and 5	Protocols are known and used by all clinical staff and regularly followed up on through some form of monitoring or oversight.
4. Good use of human resources	*With respect to your staff, what happens when different hospital areas become busier than others?*			
Score 1	Score 2	Score 3	Score 4	Score 5
Staff often end up undertaking tasks for	Between 1	Senior staff try to use the right	Between 3	Staff recognise effective human

which they are not qualified or over-qualified when they could be used elsewhere; staff do not move across units, even when they are generally underutilised.	and 3	staff for the right job but do not go to great lengths to ensure this; staff may move but often in an uncoordinated manner.	and 5	resource deployment as a key issue and will go to some lengths to make it happen; shifting staff from less busy to busy areas is done routinely and in a coordinated manner, based on the documented skills.

Full instrument available at: http://worldmanagementsurvey.org/?page_id=1848

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