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An Empirical analysis of the financial benefits of health information exchange in emergency departments

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ABSTRACT

Objective To examine the impact of health information exchange (HIE) on reducing laboratory tests and radiology examinations performed in an emergency department (ED).

Materials and Methods The study was conducted in an ED setting in Western New York over a period of 2 months. The care of the patients in the treatment group included an HIE query for every encounter, while the care of other patients in the control group did not include such queries. A group of medical liaisons were hired to query the medical history of patients from an HIE and provide it to the ED clinicians. Negative binomial regression was used to analyze the effects of HIE queries on the number of performed laboratory tests and radiology examinations. The log files of the HIE system since 1 year before the ED admission were used to analyze the differences in outcome measures between the 2 groups of patients.

Results Ceteris paribus, HIE usage is associated with, respectively, 52% and 36% reduction in the expected total number of laboratory tests and radiology examinations ordered per patient at the ED.

Conclusions The results indicate that access to additional clinical data through the HIE will significantly reduce the number of laboratory tests and radiology examinations performed in the ED settings and thus support the ongoing HIE efforts.

Key words: health information exchange, duplication reduction, cost benefit analysis

BRIEF COMMUNICATION

In this article, the authors present the results of an empirical analysis on the effects of accessing patient information through an HIE platform on the number of the laboratory tests and radiology examinations performed in an ED in Western New York. The design of this study differentiates it from previous research. This study is focused on only one ED over a short period of time, and thus its results do not suffer from the possible *confounding effects* of unobserved factors. Moreover, the design of this study ensures that the decision to use the HIE is *exogenous* and is not driven by either patient or physician characteristics. These features allow the authors to establish a stronger causal link between querying HIE and patient outcomes.

METHODS

Design

This study was conducted over the period of March 27, 2014 to May 24, 2014. A group of medical liaisons led by an experienced registered nurse were trained on how to access the health information exchange (HIE) database and query clinically relevant information from patients' medical history. During the study, the medical liaisons shadowed a specific group of physicians and mid-level practitioners during all of their working shifts (including evening and night shifts) in the emergency department (ED) and provided them with relevant medical information queried from the HIE database on their tablet. The ED providers were fully informed and their consent was acquired prior the study. The medical liaisons were instructed not to interfere with the treatment process of the ED providers and only inform them about the medical information of the patients that were accessible on the HIE. The liaisons could only access the medical records of the patients who had previously provided written consent for sharing of their records on the HIE for medical treatment and research purposes. The medical information that was accessed on the HIE included previous laboratory results, radiology examinations, hospital admissions and discharge transcripts, operative reports, and medication history.

Hereafter we use the term "*treatment group*" to refer to the patients whose care included an HIE query. Similarly, we use the term "*control group*" to refer to the patients who were treated by the clinicians who were not shadowed and whose care did not include an HIE query.

Setting

The trial was conducted by HEALTHeLINK, the regional health information exchange organization of Western New York as a part of a series of internal quality improvement projects. The investments by the state of New York on health information technology are much higher than the national average and many of the technical interoperability problems have been resolved in this state. Moreover, an exceptionally high percentage of the medical data providers have joined HEALTHeLINK. Due to these features, the available clinical information on the HIE represents a fairly comprehensive and longitudinal record of the patients. The ED in this study is located in an average-sized suburban hospital in Western New York. The number of patient visits to the ED is comparable with the median number of visits to EDs in Western New York.

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Study Population

Seven hundred and thirty-seven patients visited ED during the shifts in which medical liaisons were present. They were selected to be included in the treatment group. Thirty-nine of the patients in this group had not provided consent and thus were excluded from the study since their medical records could not be accessed. The control group included 1275 patients who were treated by the physicians in the same ED during the shifts in which the medical liaisons were not present *and* the HIE data was not accessed. For each patient in either of the 2 groups, the de-identified HIE log files were collected since 1 year prior to the ED admission date until the discharge date from ED. Based on this de-identified dataset, age, gender, and the medical history of the patients were determined. The number of laboratory tests and the radiology examinations which were performed during the study were also measured based on this dataset. In the next section, we provide the detail descriptions of these variables.

Measures

We present 2 sets of analyses in which the independent and control variables are similar but the dependent variables are different. In the analysis reported in the main text, the dependent variables, respectively, represent the number of the laboratory tests or radiology examinations which are performed during the ED visit. In this analysis, dependent variables are considered count data and can only take nonnegative integer values. The main independent variable of interest is the HIE. This is a dichotomous variable which is equal to 1 if the patient was in the treatment group and the HIE was queried during her treatment. The HIE is equal to zero if the patient was in control group and her care did not include an HIE query. The control variables include ED clinician as well as the patient's age, gender, and the number of hospitalizations, laboratory tests, radiology examinations, and hospital transcriptions that were created for her since 1 year before her admission to ED during this study. The prior utilization data is not limited to the encounters at the hospital in which the study was conducted and rather includes the entire patient encounters at all of the providers of clinical data to HEALTHeLINK. Since we do not have access to the initial diagnosis codes, the prior medical history of the patients is used as a proxy for their overall medical condition. Table 1 presents descriptive statistics on patients in both treatment and control groups.

Analysis

We apply a negative binomial regression model to investigate the effects of querying the HIE on the *number* of laboratory tests and radiology examinations which are created during a patient's visit to the ED. We hypothesize that the coefficient of the HIE variable is negative and expect that holding all of the other variables constant, querying the HIE to reduce the number of laboratory tests and radiology examinations performed during the patient's ED visit.

$$\mathrm{Log}(\mathrm{E}(\mathrm{Procedure}_i)) = \beta \mathrm{HIE}_i + \boldsymbol{C}_i'\boldsymbol{\delta} + \mathrm{e}_i \qquad (1)$$

In the above specification, procedure is the number of either laboratory tests or radiology examinations. $\boldsymbol{C}_i$ is a vector of controls for medical history and fixed clinician effects for patient i as described in the previous section. Note that equation (1) is estimated for laboratory tests and radiology examinations separately. The estimation results of equation (1) are presented in Table 2. The first panel represents the effects of the HIE along with other control variables on reducing the number of laboratory tests. The second panel represents the effects of the same set of variables on the number of radiology examinations. Additional information on the setting, sample, and sensitivity analyses appear in the online appendix.

RESULTS

According to the first panel of Table 2, after controlling for provider, patient characteristics, and medical history, the expected log count of laboratory tests decreases by 0.7248 units for patients in the treatment group. This implies that the number of laboratory tests is expected to reduce by 52% in patients whose case included an HIE query $\left(\log\left(\frac{\mathrm{HIE}}{\mathrm{noHIE}}\right) = -0.7248 \rightarrow \frac{\mathrm{HIE}}{\mathrm{noHIE}} = 0.48\right)$.

The second panel of Table 2 presents the effects of the HIE on the number of radiology examinations created for patients during the ED visit. Ceteris paribus, the expected log count of radiology examinations decreases by 0.4363 units for patients in the treatment group. This

Table 1: Descriptive Statistics on Patient Characteristics

Variable	Treatment group, $n = 698$			Control group, $n = 1275$			$H_0 : \mu_C - \mu_T = 0$
	Mean (SD)	Min	Max	Mean (SD)	Min	Max	*t*-value
Age	54.94 (20.44)	6	90	52.33 (21.95)	2	90	−2.64**
Female = 1	0.54 (0.44)	0	1	0.57 (0.49)	0	1	1.01
Prior laboratory tests	11.44 (32.90)	0	344	13.59 (41.58)	0	668	1.26
Prior radiology examinations	1.59 (3.72)	0	34	1.78 (4.13)	0	52	1.03
Prior transcriptions	0.33 (1.18)	0	9	0.41 (1.98)	0	40	1.06
Prior hospitalizations	0.11 (0.46)	0	5	0.13 (0.68)	0	10	0.76
Count of Laboratory tests during the study	14.18 (25.07)	0	213	15.39 (28.56)	0	340	0.97
Count of Radiology exams during the study	1.81 (2.38)	0	22	2.30 (3.12)	0	33	3.96**
At least one Laboratory test during the study	0.62 (0.49)	0	1	0.82 (0.0.39)	0	1	9.23**
At least one Radiology examination during the study	0.63 (0.48)	0	1	0.83 (0.37)	0	1	9.83**

**significant at $P < .01$; *significant at $P < .05$

Table 2. The effect of HIE on reducing the number of procedures performed during ED visit

Parameter	Panel 1 (Laboratory)	Panel 2 (Radiology)
	Estimate (Std. Err.)	Estimate (Std. Err.)
Intercept	1.04 (0.11)**	−0.46 (0.08)**
HIE	−0.72 (0.13)**	−0.44 (0.07)**
Age	0.02 (0.001)**	0.01 (0.001)**
Female = 1	−0.24 (0.07)**	−0.17 (0.04)**
Prior laboratory tests	0.007 (0.002)**	0.0004 (0.0009)
Prior radiology exams	−0.005 (0.01)	0.04 (0.01)**
Prior transcriptions	0.019 (0.03)	0.03 (0.02)
Prior hospitalizations	0.07 (0.12)	−0.06 (0.07)
Provider 1	0.67 (0.09)**	0.68 (0.07)**
Provider 2	0.39 (0.11)**	0.41 (0.09)**
Provider 3	1.09 (0.15)**	0.74 (0.10)**
Provider 4	1.26 (0.16)**	0.78 (0.10)**
Provider 5	0.43 (0.19)*	0.35 (0.14)*
Provider 6	0.98 (0.14)**	0.61 (0.09)**
	Dispersion: 1.8551 (0.06)**	Dispersion: 0.5018 (0.03)**
	AIC: 13 555.69	AIC: 7260.79
	Deviance: 2274.12	Deviance: 2026.72

**Significant at $P < .01$; *significant at $P < .05$.

implies that the number of radiology examinations is expected to reduce by 36% in patients for whom their care includes an HIE query $\left(\log\left({}^{HIE}/_{noHIE}\right) = -0.4363 \rightarrow {}^{HIE}/_{noHIE} = 0.64\right)$.

Note that variables provider 1 to provider 6 capture the fixed effects associated with the 6 different ED providers in the treatment group. The coefficients of these variables compare them with other providers in the control group.

DISCUSSION

To the best of our knowledge, this is the first study in which querying the HIE was included in the treatment process of all the patients in a treatment group, while the care of the others in the control group did not include an HIE query. This feature of our experiment design enables us to avoid endogeneity and confounding effects and thus to establish casual links between the HIE queries and outcome measures. According to our analysis, accessing additional clinical data through the HIE in the ED settings can reduces the number of orders for laboratory tests and radiology examinations by, respectively, 52% and 36%.

Findings of this research may not be generalizable to other areas because HEALTHeLINK has very high and longstanding participation rates among ambulatory providers. As such, the information within the HIE system represents a fairly comprehensive and longitudinal record. Since the potential benefits of an HIE is proportionate to the volume of clinical data that can be accessed on it,[1–3] similar effects may not be observed in other HIE settings. Another limitation to the external validity of this study is the use of the medical liaisons. Not all other HIE efforts will have staff dedicated to facilitate provider access to information. The effects in other settings may be further attenuated due to this feature our research. However, we felt that the additional staff were best approach to exploring the impact of the additional information available from the HIE and avoiding the low usage rates that limit other studies[4–13] in which HIE usage is completely voluntary.

The salient effects of querying the HIE on reducing the number of test and examination orders further highlights the importance of integrating HIE queries with the routine workflow of ED providers. A hundred percent rate of querying which was implemented in this trial can be achieved by reengineering the workflow processes and implementing automatic querying technologies.

Since we did not have access to initial diagnosis codes or the acutely level of patients, we could not directly control for these measures. To overcome this limitation, the number of previous medical records and hospitalizations are used a proxy for adjusting the differences in the risk levels among patients. Moreover, ethically we are not able to conduct a completely randomized trial by avoiding the care providers to access HIE for the patients in the control group and can only eliminate those rare instances from the study. Although this introduces some bias in the study, the bias will only lead to underestimation of the HIE effects. See online appendix for further discussions.

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COMPETING INTERESTS

The author is a Scientific Adviser to HEALTHeLINK. He does not receive financial compensation from HEALTHeLINK.

CONTRIBUTORS

The author is solely responsible for this work.

SUPPLEMENTARY MATERIAL

Supplementary material is available online at http://jamia.oxfordjournals.org/.

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