Factors Associated with Health Information Exchange System Usage in a Safety-Net Ambulatory Care Clinic Setting

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Abstract

The Meaningful Use criteria promises to make health information exchange (HIE) much more widespread. However, the usage of the information systems made available by existing HIE efforts tends to be very low. This study sought to examine the factors associated with usage of an operational HIE system during ambulatory care visits to safety-net clinics. Overall the HIE system was accessed for 21% of encounters. However, system access took on two distinct forms. In general, usage was more likely for patients with recent emergency department visits and chronic conditions. This study indicates the organizational commitment to engage in HIE does not necessarily mean that the information systems will be always used. In addition, system usage will take on various forms for different reasons. These results reveal considerations for the development, operation and evaluation of HIE efforts.

Keywords

Electronic health records; Health information exchange; American Recovery and Reinvestment Act; Ambulatory Care Facilities; Indigent

Introduction

Policy makers, practitioners, and researchers anticipate the process of electronically sharing patient level clinical and demographic data among organizations, health information exchange (HIE), [1] will transform healthcare. This improved mode of health information sharing has the potential to improve patient safety, [2] make the delivery of care more

timely, [3] reduce waste, [4] foster patient-centered care, [5] and support public health [6]. Already, around 200 exchange efforts exist nationwide [7] and hundreds of organizations are engaged in HIE [8]. Furthermore, the financial incentives tied to the finalized Stage 1 Meaningful Use criteria, which requires the annual testing of electronic health record systems' exchange capabilities, will promote the widespread adoption of HIE by hospitals and other healthcare organizations [9]. However, more than just the organizational adoption of HIE will be required to realize all these potential benefits. Quality improvements and cost savings will depend upon actual usage of HIE systems.

Unfortunately, usage of the information systems that are the result of HIE efforts is frequently very low. For example, among emergency departments participating in an exchange effort, the HIE system was only accessed for 0.5% of patient encounters [10]. A more recent evaluation, also among emergency departments found usage was around 10% of patient encounters [11]. Significantly, this study also reported substantial variation in usage across sites. Our own research found emergency department users accessed an HIE system for 2.3% of all encounters [12]. Looking beyond the emergency department, one local healthcare information infrastructure reported approximately 1% of patients were accessed by the systems registered users, [13] and a review of HIE efforts repeatedly found only 10%–20% patients were accessed [14].

These low levels of usage may hinder the effectiveness of HIE efforts. The purpose of HIE is to support the work of caregivers by providing access to previously inaccessible information [15]. However, if the system that provides the necessary information is not utilized, it becomes difficult to expect changes in the process of care. Multiple HIE systems and architectures require the users to initiate the search for or transfer of information from other providers [14]. Human interaction is even conceded under select scenarios for the Direct Project [16]. The adoption of technology is not sufficient for quality improvements; actual use is required [17].

In light of the increasing pressures to utilize HIE, this exploratory examination identified the factors associated with usage of an operational HIE system during ambulatory care visits to safety-net clinics. Modifying our conceptualization of usage employed in our previous research, we examined both *encounter-related* HIE system usage, which occurred within one business day of an appointment, and *retrospective usage*, which occurred several days after an encounter. This secondary data analysis was limited to characteristics of the encounter and the patient suggested by the small existing literature on HIE and previous examinations of information system acceptance. Measures of patient complexity, which may make the task of providing care more difficult thereby prompting the need to seek additional information decision making, [18] are consistent with professionals' perceptions that HIE may be of greatest benefit to the sickest patients [19] and was suggested by our previous research [12, 20]. In addition, these systems support the coordination of patient care [5] by making information from multiple organizations available [15] thereby meeting the needs of primary care providers [21]. Therefore, we also explored the association between previous utilization and system usage. These results help describe and quantify under what circumstances HIE system usage appears most appropriate or beneficial to individual users and can be applied to HIE development, health care, and related health policy.

Methods

This study examined HIE system usage in primary care clinics participating in the Integrated Care Collaboration of Central Texas (ICC). Formed in 1997 as a non-profit organization, the ICC is a fully operational HIE effort encompassing Austin area safety-net providers including: multi-hospital systems, public and private clinics, federally qualified health

centers, and city public health clinics. Similar to select efforts across the country, the ICC is organized around the medically indigent and the exchange effort does not systematically include encounters covered by private insurance or Medicare.

Member organizations contribute patient-level clinical and demographic data to a master patient index and centralized clinical data repository called I-Care through secure electronic interfaces. I-Care is a proprietary system that exists independent of each organization's clinical data repository. Nightly extractions from the members' clinical data repositories concerning the data necessary for patient identification and matching, demographics, payors, encounter locations and dates, providers, diagnoses codes (ICD-9), procedure codes (CPT or ICD-9 depending on the member), and medications (if available) are uploaded to I-Care. In turn, authorized users at participating healthcare organizations may access the database via a secured website and view user records of patients who have consented to system inclusion. Registered I-Care users include physicians, nurses, physician assistants, administrative staff, public health professionals, social workers, psychiatrists, and others.

The participating study clinics are two urban community health centers operated by a non-profit hospital system. The two sites offer primary care services, see patients on sliding fee scales, and accept public insurance. Both clinics employ a similar number of staff (14–15 FTEs), have a similar number of patient encounters a year (approximately 10,550 to 12,250), and follow the same policy and procedure directing I-Care system usage. The policy states access of the system for the purpose of printing select screens is part of the chart preparation activities for all patients—effectively mandating system usage. The clinics do not possess an electronic health record system, so the relevant I-Care screens are printed and included in the paper chart.

The study sample includes all patient encounters between January 1, 2006 and June 30, 2009 at the two clinics. We limited the sample to patients aged 19 to 64, those who resided within the Austin metropolitan statistical area, and who had consented to system inclusion. We excluded encounters among children from the study because they have very different utilization patterns and comorbidities than adults. Those over 65 years old were also excluded because the ICC considers encounters covered by Medicare not medically indigent. The ICC operates under an `opt-in' patient inclusion model and 98.5% of encounters eligible for study inclusion had authorized I-Care access. The final dataset included 39,447 encounters by 6,393 patients.

Measures

I-Care generates electronic logs to document users' activities (patient viewed, date, etc) as part of HIPPA compliance. Using these log files we defined HIE usage as one of two temporally determined types of system access. Authorized users may access patient information at any time, so user sessions and encounter information are effectively stored independently in the system. Through interviews we learned clinic staff frequently access the HIE system the business day prior to patient appointments to print records and have also accessed the system the business day after the visit to collect additional information. We classified the first type of usage as *encounter-related usage*. To identify encounters with this type of usage, we matched records based on patient identifier, encounter date, system use date, user's reported work location, and place of encounter. The second type of usage we labeled as *retrospective usage*. Previous analyses of usage patterns for all I-Care users indicated a type of HIE system usage that reviewed or searched for patients many days or weeks after the encounter date [22]. For encounters that did not have any *encounter-related* usage, we considered any usage within month following the encounter as *retrospective usage*. We again matched records based on patient identifier, dates, user's reported work location, and place of encounter. In cases where the patient had multiple encounters within a

month, any *encounter-related* usage did not count as *retrospective* usage for the earlier encounters.

We constructed variables from data in I-Care. Patients were described by age, sex, and race/ethnicity. To describe recent utilization patterns, we determined if the patient had any emergency department visits in the 3 months prior to the encounter and any inpatient hospitalizations in the 12 months prior to the encounter. Because the information in HIE systems comes from multiple organizations, these measures included encounters at other facilities. Furthermore for each patient at the time of their encounter, we determined the individual's Herfindahl-Hirshman Index [23] score using the location of all primary care visits. One minus this score yielded an index of fragmentation, with high scores indicating a greater reliance on multiple sources of primary care. Economic measures such as this have been previously applied in the literature in order to measure care patterns [24]. To ease interpretation the index was scaled to range from 0 to 100. Lastly, we divided the payer associated with the encounter into two groups reflecting reimbursement rates: Medicaid and charity care / self-pay.

In terms of clinical indicators, we measured patient complexity in terms of the adapted Charlson comorbidity index score (excluding use of warfarin) [25]. The substance abuse and psychoses conditions from Elixhauser and colleagues' comorbidity list were included as independent predictors [26]. We considered any diagnosis of these conditions at any type of healthcare encounter during the study period as indicative of having the condition. We used the Agency for Healthcare Research and Quality's Chronic Condition Indicator definitions to identify encounters associated with chronic diseases [27].

Analysis

The unit of analysis was a primary care encounter. Frequencies and percents are used to describe the study sample. Associations between independent variables and usage were examined using multinomial logistic regression modeling. To account for non-independence for repeated encounters by the same patient, we applied the clustered sandwich estimator to adjust the standard errors. To adjust for confounding, we created best fitting multivariate models in Stata using a backward selection modeling approach looking for improvements in Akaike and Bayesian Information Criterion values. We set the significance testing for the coefficients at alpha=0.05. The parameter coefficients were exponentiated to express odds ratios and 95% confidence intervals.

Results

The HIE system was accessed for 21.1% of all encounters. Specifically, encounter-based usage was more common (n=7,101) than retrospective usage (n=1,227). This frequency of overall usage is consistent with or even higher than previous reports of HIE usage.[10–14]

Table 1 describes the study population. The majority (63.2%) of encounters were with Hispanic patients, which reflects the geographical location of the exchange effort. Nearly two-thirds of encounters were with female patients (66.9%) and most encounters were not covered by public insurance (76.5%). Again, the high percent of uninsured encounters reflects the population included in the exchange effort. In terms of heath status, nearly half of the study encounters (44.5%) were associated with a chronic condition, and fewer than one in ten encounters (8.3%) were with a patient who had a history of mental illness excluding depression.

Table 2 includes the unadjusted and adjusted associations between the independent variables and type of HIE usage. After controlling for confounding factors, the best fitting model

contained four variables associated with encounter-based usage. In terms of patient demographics, the odds of encounter-based usage were statistically higher for encounters with female patients (odds ratio (OR)=1.12; 95% Confidence Interval (95%CI)=1.04, 1.21) and patients in the oldest age group (OR=1.16; 95%CI=1.03, 1.31). Encounters that occurred within 3 months after an emergency department visit had a 13% higher odds of encounter-based usage (OR=1.13; 95%CI=1.04, 1.22) than encounters without recent emergency department visits. Lastly, encounters associated with a diagnosis of a chronic condition had nearly a 20% higher odds of usage (OR=1.19; 95%CI=1.12, 1.26) than encounters without the diagnosis of chronic condition.

Also included in Table 2 are the unadjusted and adjusted associations with retrospective usage. More factors were statistically associated with retrospective usage than encounter-based usage. After controlling for confounding, encounters among female patients were associated with retrospective usage (OR=1.17; 95%CI=1.00, 1.36) as were encounters for chronic conditions (OR=1.17; 95%CI=1.03, 1.33). Different than encounter-based usage, encounters with Hispanic patients had higher odds (OR=1.27; 95%CI=1.09, 1.48) of retrospective usage. Like encounter-based usage, recent emergency department visits were also associated with retrospective usage (OR=1.35; 95%CI=1.16, 1.58). Previous hospitalizations were also (OR=1.33, 95%CI=1.07, 1.65) associated with retrospective usage. Lastly, increasing comorbidity scores (OR=1.04; 95%CI=1.00, 1.07) and fragmentation of care index scores (OR=1.52; 95%CI= 1.04, 2.23) were associated with retrospective usage.

Discussion

Encounter-based usage was the most common type of usage and associated with older and chronically ill patients. HIE system usage in a *retrospective* manner was associated with complex patients and those relying on many different providers. These differing forms of usage and associated factors all were seen within the same healthcare system and in the ambulatory care setting. These results reveal considerations for the development and operation of HIE efforts, can help guide evaluation efforts, and suggest when the information made available by HIE may be most useful.

This study suggests what factors are potentially useful or important in the context of HIE. First, for both encounter-based and retrospective usage, the odds of system access were higher for encounters where the patient had recently visited the emergency department. This finding could be deemed a very desirable. Patients often rely on the emergency department as a source of care; unfortunately, afterwards the patient's primary care provider frequently is not well informed about the care received during that visit [28]. This study suggests an increase in the odds that those types of knowledge deficits are being rectified. Second, factors potentially identified during encounters, such as increased comorbidity, a reliance on a lot of different providers, or past hospitalizations could suggest systems were used retrospectively to help understand and improve patient care. This second finding might reflect some support of the clinics' social work efforts and would seem illustrate an important use of HIE, especially given growing emphasis on preventable hospitalizations and rehospitalizations. Third, few factors related to patient or encounter characteristics were significantly associated with encounter-based usage. This result suggests that system use/ disuse may be more related to the organization's usage policy (e.g., workflows, scheduling processes, staff time constraints, etc.) rather than the patient or encounter attributes.

With respect to evaluation, these results argue for careful considerations of what constitutes health information technology usage. HIE advocates justifiably point to the beneficial effects of access to previously inaccessible information during the patient encounter [15]. In

this study, the primary mode of usage was clearly intended to benefit the current encounter. However, even within the clinical setting, other timings and reasons for HIE usage must be considered. Alerted to alternative types of usage through interviews with staff members, and borne out by the data, 3.1% of all encounters resulted in usage at a later time. Simply limiting the usage construct to encounter-based access would have excluded a unique temporally-defined mode of usage. Going beyond this analysis, studies with sufficient sample sizes could create even more detailed understandings of usage by also incorporation types of information accessed.

While organizations adopt the information systems and technologies necessary to engage in the process of information exchange, it is the clinic staff that actually put these systems to use. Organizations in all industries frequently adopt information systems only to find that the anticipated benefits are not realized because individual usage is incomplete or occurs in unanticipated ways [29, 30]. For example, the policies and procedures of the clinics under examination in this study directed HIE system access for all patients. However, system access was not universal. As a further demonstration of the disconnect between individual behavior and organizational expectations, the clinics' usage policy included nothing about looking up patients retrospectively. This variance from expected usage behavior is not pointed out in order to contend usage policies and procedures are completely ineffective. Among all ICC primary care participating organizations, the two clinics in this study had a usage policy and boasted the highest levels of usage. Likewise, the MidSouth eHealth Alliance-based study noted a much higher level of HIE usage in an emergency department that had an established usage protocol, [11] and the Massachusetts regional information exchange, MA-SHARE, also reported increased usage when system access was incorporated into emergency department workflow [31]. Administrative policies and procedures may be of varying effectiveness, but their presence indicates some intention and foresight to integrate system usage into healthcare's complex workflow. Furthermore, understanding and fostering individual usage is particularly important in the case of HIE, because of the wide variation in technical architectures. In HIE architectures, in which an organization's policies do not allow for the direct integration of exchange partners' information, users are effectively required to access one or more additional information systems to retrieve patient information. Therefore, in stand-alone HIE information systems, physician portals, or personal health record-based exchange, understanding the determinants of access and fostering actual usage of such systems are critical. In contrast, when information received from exchange partners is directly integrated into the user's EHR the concept of usage is different. In these instances, the need to understand and foster individual usage does not require promoting access of additional information systems, but ensuring the information from HIE is applied. Based on these results, an interoperable EHR that automatically displays patient information supplied through HIE activities to the end user may be a better fit for clinical workflow, and used more frequently by clinicians, than standalone HIE systems.

As an examination of a single HIE, this study is limited in generalizability. Other HIE efforts may differ in key respects such as software, architecture, number of member organizations or populations served. Specifically, our results may not reflect settings where HIE information is consumed completely in electronic format. An area of future research could be the comparison of environments that still utilize paper records with systems that achieve a higher level of electronic integration. In addition, this study utilizes secondary data and is cross-sectional in nature. Thus, we were limited with respect to what factors we could consider. This limitation was most apparent in our inability to include any individual user characteristics. Individual work roles, training, experiences and perceptions of information systems are critical variables to understanding usage. Unfortunately, they were not available for this study. Also, the cross-sectional design obscures potentially important events during

the study period. For example, due to employment changes within clinics, system users varied within the study period. Also, while the HIE usage policies and procedures pre-dated our study period by 18 months, the actual HIE system changed over time. Early in the study period, four new locations (a psychiatric hospital, a newly constructed hospital, a call center, and a medical assistance program) began sharing data and the exchanged instituted a new program to authorize access of patient data in emergency situations. However, neither of these evolutions changed how users logged on, searched for, and accessed information. Lastly, we do not know if the information retrieved from the system was actually applied to the care of the patient. While that fact does not directly affect our results, that restriction due to secondary data is a potential limitation for any future study looking at the relationship between HIE usage and patient outcomes.

Significant support exists for the widespread adoption and implementation of HIE – most notability in the form of the Meaningful Use incentive structure. Additional interest might even come from the promotion of Accountable Care Organizations, which will require information sharing across providers to take responsibility for the health of a defined population. Even with a growth in interest, this study like others finds lower levels of individual usage than might be hoped for by advocates and supporters of HIE. However, usage should be an obvious concern when the retrieval of information created by other organizations requires individuals to shift attention to a different record or information system. Organizations may be able to better foster the use of the information made available by HIE by integrating more external information in their EHRs. Policies to "tag" external received data or to simply note in the record the information source could reassure users' potential concerns about trusting information created by other organizations. This study has underscored the point that attention to how and why users actually utilize HIE systems which might help in system improvement, foster user acceptance, and hopefully lead to HIE's promised health benefits.

Acknowledgments

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Table 1

Characteristics of primary care encounters at two outpatient clinics participating in the Integrated Care Collaboration by type of health information exchange system usage, 12/2006–6/2009

	All encounters n=39,447	No HIE usage n=31,119	Encounter-based usage n=7,101	Retrospective usage n=1,227
Female, %	66.9	66.1	69.7	70.4
Age, %				
19 to 29	12.9	13.5	10.4	12.9
30 to 39	23.3	23.6	22.0	24.4
40 to 64	63.8	63.0	67.6	62.8
Race/ethnicity, %				
White non-Hispanic	22.2	22.9	19.4	19.8
African American	5.6	5.7	5.5	6.3
Hispanic	63.2	62.8	64.4	66.7
Other / unknown	9.0	8.7	10.4	7.2
Charity care, %	76.5	76.8	76.6	70.3
Utilization history				
Emergency department visit in past 3 months, %	17.9	17.3	19.5	24.1
Hospitalized in past 12 months, %	8.6	8.3	9.1	12.2
Mean fragmentation score (standard devitation)	7.7 (15.4)	7.7 (15.4)	7.7 (15.3)	8.9 (16.2)
Mean Charlson index score (standard deviation)	2.0 (2.4)	1.9 (2.3)	2.2 (2.5)	2.3 (2.6)
History of substance abuse, %	3.0	2.9	3.0	4.5
History of psychosis, %	8.3	8.2	8.3	9.1
Chronic diseae indicator, %	44.5	43.4	48.6	47.6

Table 2

Encounter characteristics associated with type of health information exchange usage

	Encounter-based usage		Retrospective usage	
	Unadjusted OR 95%CI	Adjusted OR 95%CI	Unadjusted OR 95%CI	Adjusted OR 95%CI
Female	1.18 (1.10, 1.27)**	1.12 (1.04, 1.21)**	1.23 (1.07, 1.41)**	1.17 (1.00, 1.36)*
Age				
19 to 29	1.00	1.00	1.00	1.00
30 to 39	1.21 (1.07, 1.38)**	1.12 (0.98, 1.27)	1.08 (0.88, 1.33)	1.13 (0.90, 1.42)
40 to 64	1.40 (1.24, 1.56)**	1.16 (1.03, 1.31)*	1.04 (0.86, 1.26)	1.02 (0.82, 1.27)
Race/ethnicity				
White non-Hispanic	1.00	1.00	1.00	1.00
African American	1.02 (0.87, 1.20)	0.92 (0.78, 1.08)	1.30 (0.98, 1.72)	1.09 (0.81, 1.46)
Hispanic	1.08 (1.00, 1.16)	0.98 (0.91, 1.06)	1.24 (1.08, 1.42)**	1.27 (1.09, 1.48)**
Payer				
Public insurance	1.00	1.00	1.00	1.00
Charity care	0.99 (0.92, 1.08)	1.06 (0.97, 1.15)	0.71 (0.62, 0.82)**	0.78 (0.67, 0.91)**
Utilization history				
Emergency department visit in past 3 months	1.16 (1.07, 1.25)**	1.13 (1.04, 1.22)**	1.52 (1.32, 1.75)**	1.35 (1.16, 1.58)**
Hospitalized in past 12 months	1.09 (0.98, 1.23)	1.00 (0.88, 1.13)	1.53 (1.25, 1.87)**	1.33 (1.07, 1.65)*
Fragmentation of care score	1.03 (0.84, 1.27)	1.05 (0.85, 1.30)	1.61 (1.10, 2.34)*	1.52 (1.04, 2.23)*
Charlson index score	1.04 (1.03, 1.06)**	1.01 (0.99, 1.03)	1.06 (1.04, 1.09)**	1.04 (1.00, 1.07)*
History of substance abuse	1.03 (0.82, 1.29)		1.57 (1.17, 2.11)**	
History of psychosis	1.02 (0.89, 1.16)		1.12 (0.91, 1.39)	
Chronic disease indicator	1.23 (1.17, 1.30)**	1.19 (1.12, 1.26)**	1.18 (1.05, 1.33)**	1.17 (1.03, 1.33)*

*
$p<0.05$

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$p<0.01$