Health information exchange usage in emergency departments and clinics: the who, what, and why

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ABSTRACT

Objective Health information exchange (HIE) systems are being developed across the nation. Understanding approaches taken by existing successful exchanges can help new exchange efforts determine goals and plan implementations. The goal of this study was to explore characteristics of use and users of a successful regional HIE.

Design We used a mixed-method analysis, consisting of cross-sectional audit log data, semi-structured interviews, and direct observation in a sample of emergency departments and ambulatory safety net clinics actively using HIE. For each site, we measured overall usage trends, user logon statistics, and data types accessed by users. We also assessed reasons for use and outcomes of use.

Results Overall, users accessed HIE for 6.8% of all encounters, with higher rates of access for repeat visits, for patients with comorbidities, for patients known to have data in the exchange, and at sites providing HIE access to both nurses and physicians. Discharge summaries and test reports were the most frequently accessed data in the exchange. Providers consistently noted retrieving additional history, preventing repeat tests, comparing new results to retrieved results, and avoiding hospitalizations as a consequence of HIE access.

Conclusion HIE use in emergency departments and ambulatory clinics was focused on patients where missing information was believed to be present in the exchange and was related to factors including the roles of people with access, the setting, and other site-specific issues that impacted the overall breadth of routine system use. These data should form an important foundation as other sites embark upon HIE implementation.

INTRODUCTION

Americans increasingly seek healthcare from multiple organizations for a variety of reasons (eg, insurance requirements and limitations, general population mobility, specialty care provider availability).¹ The process of requesting and retrieving clinical information from these disparate organizations is cumbersome, time-consuming, and often unsuccessful, especially when patients do not recall the variety of locations in which they have received care. As a result of patients receiving care from different healthcare settings, providers either knowingly or unknowingly make decisions with incomplete patient data.^{2–4} This knowledge ‘blind spot’ increases healthcare costs when previously performed tests and procedures must be duplicated

to provide decision makers with data. Furthermore, in some settings, such as in public health^{5–7} and medication prescribing,^{8,9} incomplete data can compromise patient safety.

The concept of inter-organizational health information exchange (HIE) supported by technology has evolved over the last 30 years. A 2008 survey found 44 operational exchanges in the USA.¹⁰ HIE goals include improving patient care through more complete data availability, increasing work efficiency by providing baseline patient information, reducing cost by decreasing duplication of procedures and services, and benefiting public health efforts.^{5,11–13} Initial HIE efforts included community health information networks such as the Santa Barbara Care Data Exchange¹⁴ and local health information infrastructure such as the Indiana Patient Care Network.¹⁵

Although the concept of HIE may be innately appealing, these systems, like all health information technology, are inconsistently adopted in practice. Sustained information technology adoption is related to a variety of factors, including intrinsic interest in using innovations¹⁶ as well as unrealized expectations, as in Gartner’s hype cycle.¹⁷ A recent systematic review by Boonstra¹⁸ identified eight categories of barriers that impacted physician acceptance of electronic medical records (EMRs), including financial, technical (skill/support), time constraints, psychological (attitudinal), social, legal, organizational, and change process obstacles, with the latter two impacting the influence of the former categories. Any or all of these factors may impact the willingness of physicians to adopt HIE. In fact, many early HIE efforts failed due to organizational, financial, and attitudinal barriers.^{14,19}

The Mid-South eHealth Alliance (MSeHA) is one example of an operational exchange. Early evaluations of the exchange demonstrated a high level of user satisfaction, which has been formally evaluated and the results published elsewhere.^{20,21} *The goal of this evaluation is to characterize the extent and patterns of use as they relate to different HIE workflows, and to inform the national discussion about both HIE implementation strategies and usage benchmarks.*

METHODS

Setting

The study took place in the Memphis Metropolitan Statistical Area and focused on a HIE in use in 12 emergency department (ED) sites and two ambulatory groups (comprised of nine total clinic sites) throughout the region. Since 2005, the non-profit MSeHA has governed and managed HIE services

among major healthcare provider organizations in the Memphis Metropolitan Statistical Area. Information available from participating organizations varies slightly among organizations. All major hospitals provide hospital discharge summary notes, laboratory data, pathology reports, radiographic reports, other transcribed notes, and a range of other clinical and administrative documents. Both ambulatory groups and all 12 ED sites provide demographic information, registration information, and a limited number of clinical data types. Clinicians began accessing HIE data in their EDs in May 2006, and later obtained access on hospital wards and in ambulatory clinics. As of October 1, 2010, clinicians had access to over 7.5 million encounter records on 1.7 million patients, 45 million laboratory tests, 5 million radiology reports, and 2.1 million other reports and documents. Patients are offered the chance to 'opt out' from HIE participation at the time of every encounter at participating hospitals and clinics.

Providers log into the exchange using a secure token and a password. Once they access the system, they are able to search for any patient by social security number, first name, last name, date of birth, and gender. Providers may review any record in the exchange, whether or not the patient is known to be registered for a visit. This decision was made to allow providers the flexibility to review records before, during, or after encounters, as needs warrant. Although providers may review any record, they may do so only via approved IP addresses, and after providing two-factor authentication using a user ID, password, and a key displayed on a centrally provided token linked to that user ID (RSA SecurID; <http://www.rsa.com/>). The system combines patient data from disparate sources onto one screen view. As depicted in figure 1, the exchange provides a unified view of patient demographic information, radiology reports, laboratory test results (in tabular or graphical trend format), procedure results, discharge summaries, encounter summaries, and medication lists based on medication history data provided by the Surescripts national e-prescribing message communication network.

Of note, the State of Tennessee underwent some dramatic changes during the study related to the reorganization of

TennCare, Tennessee's Medicaid program, which, in 2004, was dissolved and reorganized due to excessive costs. These changes impacted ED utilization and may have had other impacts on regional healthcare; however, these changes were not isolated to any single site in our study.

Clinicians also are able to determine which patients have data in the exchange by reviewing the Recent Registration screen (figure 2) displaying all patients who have arrived for a visit at each specific site. This screen contains patient-specific data, in addition to a column describing whether this patient has data in the exchange from remote sites.

The appropriate regulatory groups at all participating organizations, including Institutional Review Boards when available, approved study procedures before data collection started.

Study design

This population-based cross-sectional study used quantitative methods to assess usage patterns and qualitative methods to assess reasons for and consequences of use.

Quantitative methods: usage trends

We assessed usage trends and patterns for the exchange using multiple sources of quantitative data. We extracted login and logout data from audit logs, and summarized each variable each month. Variables included the number of patient visits for each clinic site, HIE access per site, roles of each exchange user, and overall logon activity per month. Variable definitions are defined as follows:

- ▶ A *visit* is defined as a patient registration event. Two or more registration events within 24 h at the same site are considered the same visit, to account for patients who may need to be registered for procedures or for a hospital admission.
- ▶ *HIE access* is defined as any review of HIE-based patient data. Providers who access the HIE may review patient data in two ways. First, they may select a patient from the Recent Registration screen (figure 2) that displays the patient name and the number of remote sites from which there are data for the patient. This screen can help providers decide if there is

Figure 1 Health information exchange Overview screen (showing test data only).

The screenshot displays the StarPanel Lite V1.7.3 web application. The interface is divided into a left sidebar for navigation and a main content area. The sidebar includes links for 'MSEHA Policies', 'Help', 'Home', 'Log Out', 'Lock', and 'Clear'. Below these is a 'Patient Search' section with fields for Name, SSN, MRN, and a search button. The main content area shows a patient overview for 'VEHL, JESSICA L (02/03/1954 - 55YO F)'. It includes a 'View All' button and a table of encounters. The table has columns for Facility, MRN, PatName, Service Date, Type/Visit Reason, and Diag. ICD-9. The encounters listed are for Chest Pain and Vascular Insufficiency.

Facility	MRN	PatName	Service Date	Type/Visit Reason	Diag. ICD-9
10005	VEHL, JESSICA L	2006/12/18	E	CHEST AND RIGHT LEG PAIN	786.50: CHEST PAIN NOS<< 729.5: PAIN IN LIMB 724.5: BACKACHE NOS
10005	VEHL, JESSICA L	2006/12/11	E	CHEST PAIN	786.50: CHEST PAIN NOS
0000030005	VEHL, JESSICA L	2006/10/18	O	VASC INSUFF INTES NOS	557.9: VASC INSUFF INTES NOS
0000030005	VEHL, JESSICA L	2006/10/11	O	SEBACEOUS CYST US IF NEEDED	

Figure 2 Health information exchange Recent Registration screen (showing test data only). This screen, which commonly is the launching off point for providers, displays whether the exchange contains data from other sites.

value in selecting that record for review. One of 12 EDs and none of the clinic sites initially were able to provide the data to populate this screen; however, by the end of the first year, all emergency sites provided these data and now use this screen almost exclusively to select patients. Providers also may search for a patient record using the patient's name, date of birth, and gender. The provider will then be shown all patients who match these search criteria (with records that correspond to the same individual across sites aggregated visually into one selectable record). In both cases, we do not consider the record accessed until after a patient is selected for review and the exchange has displayed the screen shown in figure 1.

- Provider *logon activity* is defined as the number of times a provider logs into the HIE in a month. The logon process for the exchange uses a two-factor method with a 30-min idle automatic logout. A provider must be logged in to perform any action with patient data. We used a relatively non-specific metric because of numerous scenarios requiring users to log in multiple times in 1 day, even for the same patient, and due to the vagaries of shift work making the pattern of work different for each provider. For example, ED physicians may work any number of days of the week, and may work long or short shifts. We were not able to map the schedule to the audit file ID and therefore could not account for varying work hours.

We determined the data types that were accessed and the roles of providers accessing exchange data using exchange logs and by linking specific data elements with data access logs. We combined all ambulatory clinics from one organization into one set, rather than reporting each ambulatory clinic separately.

To characterize use, we reviewed data from usage logs each month. The audit process recorded entries for each logon and record access (including the specific data elements displayed or printed), recording the date, time, and site of access. From these data, we were able to use programmed scripts to create the variables defined above and to summarize who was accessing the system.

To understand the rationale for system access (when users chose to access it and why), we also collected feedback from

a convenience sample of providers on comment cards and through a feedback system integrated into the software. These data were collected over a 1-month period approximately 1 year after the system was in use at all sites. We received 369 total responses, representing 12% of all patient visits with HIE access during that period, which we reviewed and categorized.

To better understand why providers used the exchange, the study team conducted open-ended interviews with MSeHA operations team members and with key informants. The initial sampling plan included six ED sites and nine ambulatory clinic sites. A researcher (KMU) first conducted broad observations at each site except one ambulatory site where we were unable to schedule unstructured observation. Broad observation disclosed a wide spectrum of user types, because HIE use typically happened on computers that were used for multiple other purposes. The observer spent some time in the areas identified as the HIE access points, but moved about to other areas to follow clinicians and get a broader perspective on how the information fit into patient care. Once this was completed, we refined our subject selection to focus more closely on people who could be observed to use the exchange. As time allowed, the researcher asked questions to clarify observations. Notes were transcribed as soon as possible after observation and were entered into NVivo 8 software for additional qualitative data analysis.

One year after the last site began using the exchange, we collected data about usage patterns to assess what data were being reviewed. We used audit data collected from January 1 until June 30, 2008. These data were able to discern access to demographic information, encounter information, clinical information, claims information, and other views of clinical or administrative data.

Statistical analysis

We assessed the comorbidity burden of patients whose records were accessed versus those whose were not by evaluating a subset of ED claims data for visits between January 1 and June 30, 2008 submitted to the Tennessee Hospital Association using a process unrelated to the HIE. To create this data set, we first used audit log data to identify visits where HIE was accessed.

We labeled these encounters, and then matched them to encounter data received by the Tennessee Hospital Association from the entire sample of encounters in regional sites which had access to the exchange. All other encounters in that sample were labeled as 'not accessed.' For each visit, we used International Classification of Diseases (ICD) codes from that encounter record to compute a Charlson Comorbidity Index. The Charlson Comorbidity Index uses claims data and ICD codes to predict the 10-year mortality for a patient who may have a range of comorbid conditions. Each condition is assigned with a score of 1, 2, 3, or 6 depending on the risk of dying associated with this condition, which are then summed up to a total score for the patient. Therefore, each patient is assigned a score of 0 or higher.²²

Data were analyzed using SAS 9.1 macro (SAS Institute) for calculation of the Charlson Comorbidity Index and R 2.10.1 (<http://www.r-project.org/>) for the rest of the analyses. We summarized usage with frequency and percentage. We used the χ^2 test to compare the HIE access rate between primary care clinics and ED sites and the Wilcoxon rank-sum test to assess the association between a visit's Charlson score and HIE access.

RESULTS

Who used the exchange?

Figure 3 summarizes, for each month, the total number of visits across participating sites and the rate of HIE access. As sites were added, the total visit number increased with time. The HIE access rate was also increasing during the study period in general, except for one major healthcare organization which changed its HIE usage policy in June 2008 resulting in a sharp decline in HIE use. After approximately 24 months, overall rates of access steadily increased from 4% to 6.5% of patient

encounters across all participating sites. As summarized in figure 4, using data from the last month of the study, HIE access rates varied among sites, ranging from <1% to 16%. HIE access averaged 14.6% for return visits to the ED (defined as a second visit within 30 days) and 18.7% for return visits to the clinics ($p<0.001$).

HIE access rates were highest at sites serving the underserved (ED A, ED K, ED N, ED B, ED H) and lowest at sites with specialized patient populations (ED G, ED I). HIE access rates differed significantly between ED sites and clinic sites (6.9% vs 5.8%; $p<0.001$). HIE access was higher for all return visits within 30 days. In primary care clinics, return visits were associated with HIE access more often than return visits in ED sites (18.7% vs 14.6%; $p<0.001$). HIE access was significantly higher for patients with high levels of comorbidity (28% access with one or more comorbidities vs 24% access with no comorbidities; mean Charlson score of 0.47 vs 0.375; $p<0.001$). Sites with no nurse or clerk access to HIE had very low levels of access, while sites with nurses, clerks, and physicians accessing the system had the highest levels of access.

Visits typically fell into one of four categories, as shown in table 1. HIE access was lowest for visits where there was no chance of data being present in the exchange, and highest for visits where data were present from another site of care.

System usage varied by site and was related to the roles of people with HIE access and site policies governing use. Interviews disclosed a strong association between HIE access and the involvement of nursing and registration staff. For example, one of the two primary care groups printed a summary record whenever a patient was being seen for follow-up or had not been seen in over a year. This site had nearly twice the rate of access as the other primary care group. As seen in figure 3, there also was a large decrease in overall usage in June 2008, related to

Figure 3 Health information exchange (HIE) access overview. This figure depicts monthly emergency department visits at participating sites, percent of visits for which HIE data were accessed, and the number of participating sites. Total visits increased as more sites began participating in HIE. The sharp decline in HIE access in June 2008 corresponded to a policy change at one major healthcare organization, where staff access was revoked once the Recent Registration screen was implemented at that site.

Figure 4 Health information exchange (HIE) access rate by site. The figure shows rates of HIE access with 95% CIs for new and return visits, and associated logon activity for each site. Physician and nurse/clerk logon activity are shown separately. For each site, we list the total number of new and return visits, as well as the numbers of doctors and nurses/clerks who had access. Safety net sites are denoted by *. ED, emergency department.

a policy change at site ED K. This site initially permitted registrars to search for each patient in the exchange and to print out a summary sheet if any records were available from other sites. Nurses, nurse practitioners, and physicians could then choose to check the exchange based on this information. As more functionality became available, clinical security team members judged that removing access from registrars and nurses would reduce the risk of privacy breaches. Use subsequently shifted to nurse practitioners and physicians, radically decreasing HIE access rates at this site.

Usage at one pediatric tertiary care site approached 0%, despite high levels of available data in the system for their patient population. At the time the system became available at this site, very little data from external sites were available, thus providing marginal benefit for HIE use. Users initially consulted the system at a high rate, but once the limited amount of available data became clear, usage dropped precipitously. Although more data from external sites became available over time and users at the pediatric site were repeatedly notified of the additional available data, usage remained low. Users across multiple sites reported lack of awareness regarding available data and when additional data were made available.

Table 1 Health information exchange (HIE) access rates according to number and type of visits to exchange sites

	Visits, n (%)	Exchange accessed, n (%)
First visit to any exchange site (ie, no record in HIE)	289 356 (25)	7256 (2.5)
Visits only to this exchange site (ie, all data in HIE come from this site)	291 330 (25)	8597 (3.0)
First visit to this exchange site but more than one previous visit to other exchange sites (ie, all data in HIE come from another exchange site)	162 605 (14)	11 478 (7.1)
More than one visit to this site, and a history of more than one visit to other exchange site(s)	404 706 (36)	29 668 (7.3)

Which data were accessed?

Most HIE access began from the Recent Registration screen, which displayed the patients currently checked into the registration system at the local site. Because this screen listed whether or not each patient had data in the exchange from other sites, accessing this page may have been sufficient to impact further usage. In the small number of sites where the Recent Registration screen was not available, users searched for patient data using patient information such as medical record number, social security number, or a combination of demographic information including name, gender, and date of birth.

Figure 5 summarizes the frequency and types of data accessed. For the purposes of this analysis, we considered a data type accessed each time a screen of that data type was displayed for a particular patient by a specific provider. The most common usage pattern involved starting from the Overview screen. This screen provides access to all other patient-specific data in MSeHA including information on encounter date, service, and all related data. The Overview screen also lists each screen available and the percent of MSeHA use for each screen. From the Overview screen, users were able (figure 5, top) to review reports, patient demographic information, aggregated laboratory data, medication history data for one insurance provider, discharge summaries, or all data collected during a specific visit. Because multiple reports could be viewed from the report view, this page was accessed more than once for some visits. Also, two screens (Aggregated Laboratory Results and Medication List) were modified extensively after their initial roll out, based on user needs. Despite these modifications, use of these screens remained consistently low.

Percent of access is based on the total number of times the corresponding tab is selected, divided by the total number of HIE accesses during the study period. Note that both survey and observational data disclosed that users lacked clarity about the exact scope of HIE participation, the types of data contributed from different organizations, and the timing of data availability. These concerns were voiced frequently by experienced users,

turnover and organizational changes at numerous sites during the study period may have impacted HIE usage. In particular, the loss of HIE champions at some sites resulted in reductions in HIE promotion and training activities. In addition, changes in the payer mix associated with dramatic changes in the Tennessee Medicaid managed care program may have impacted HIE access by either causing an increase due to fragmented care or a decrease due to unmeasured changes in staffing or case urgency.

It is possible that we have underestimated usage in clinic settings, due to the numerous reasons for a visit that we could not exclude from this analysis. For example, patients may return to receive an immunization, to compete or return a form, or to provide follow-up data, such as a blood pressure or weight check. For most of these types of visits, use of the exchange would not be expected. HIE sites should probe deeply into the goals of HIE and the types of visits most likely to benefit from HIE access, using both standard quality improvement methodologies and discussions with clinic staff.

We used a very coarse measure to assess provider logon rates. We did this to avoid many potential confounders associated with provider-specific logon patterns related to personal choice, scheduling, machine availability, or other factors. Our measure for logon may underestimate the breadth of use if providers, despite warnings, shared their logon or remained logged in after stepping away from the computer (allowing other colleagues to use the exchange without logging in). In addition, providers were able to either review data onscreen or print out summary data. These printed summaries could have been shared among colleagues, thereby circumventing the requirement that individual providers log in to see data.

Strategies to improve overall HIE meaningful use in ED and clinic settings

We have been able to achieve a low level of sustained use, and, through this mixed-methods analysis, have identified strategies that may be associated with sustained and increased HIE adoption. Based on our findings, we would recommend five strategies to enhance HIE meaningful use.

1. Recognize the healthcare goals of the region, and make changes to the HIE that address these high priority and relevant regional goals. For example, would the system help improve immunization rates by placing the current immunization status on the dashboard? Would the system help ensure communication with the primary care provider by displaying that person's name on all printouts or on the Overview screen?
2. Design HIE systems to integrate into the workflow and, if possible to serve as a point of entry for access to all clinical data. In our system, the Recent Registration screen dashboard, which consisted of patient identifiers, but also showed whether the exchange contained data about this patient from other sites, was a useful screen for both clinicians and staff and could be an important component of any HIE system design. Technologies such as single sign-on, contextual sharing across systems, and summary views of information may be very important approaches to improve usage in busy settings not typically associated with medical record review during the encounter.
3. Provide access to HIE based on the roles people typically play in the culture's information retrieval process. It does not appear to be the case that simply providing HIE will transform the culture overnight; rather, it may be better to consider this a tool for use not only by clinicians at the point of care, but

by nurses at triage, radiologists in need of comparison studies, or hospitalists accepting a patient for admission.

4. Have standardized training available for sites beginning to use the system. Ensure that all sites have received this training and meet a minimum standard of competence.
5. Provide ongoing training and local/usage feedback as the system matures. It helped for sites to see how they were doing compared with their peers, and for sites to receive periodic 'refresher courses' for new employees or recent adopters.

CONCLUSION

The exchange of health information is a critical component of care in today's society. This study characterizes usage patterns and usage rates that have evolved with automated HIE in EDs and primary care visits, and suggests potential strategies to improve overall use in these settings.

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