

What Affects Clinicians' Usage of Health Information Exchange?

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Keywords

Quality of care, clinical workflows, health information technology policy, primary care, patient safety, accountable care organizations, the Direct Project

Summary

Background: The ability to electronically exchange health information among healthcare providers holds enormous promise to improve care coordination and reduce costs. Provider-to-provider data exchange is an explicit goal of the American Recovery and Reinvestment Act of 2009 and may be essential for the long-term success of the Affordable Care Act of 2010. However, little is known about what factors affect clinicians' usage of health information exchange (HIE) functionality.

Objective: To identify factors that affect clinicians' HIE usage - in terms of frequency of contributing data to and accessing data from aggregate patient records - and suggest policies for fostering its usage.

Methods: We performed a qualitative study using grounded theory by interviewing clinician-users and HIE staff of one operational HIE which supported aggregate patient record functionality. Fifteen clinicians were interviewed for one hour each about what factors affect their HIE usage. Five HIE staff were asked about technology and training issues to provide context. Interviews were recorded, transcribed and analyzed. Recruitment excluded clinicians with little or no familiarity with the HIE and was restricted to one community and a small number of specialties.

Results: Clinicians were motivated to access the HIE by perceived improvements in care quality and time savings, but their motivation was moderated by an extensive list of factors including gaps in data, workflow issues and usability issues. HIE access intensities varied widely by clinician. Data contribution intensities to the HIE also varied widely and were affected by billing concerns and time constraints.

Conclusions: Clinicians, EHR and HIE product vendors and trainers should work toward integrating HIE into clinical workflows. Policies should create incentives for HIE organizations to assist clinicians in using HIE, develop measures of HIE contributions and accesses, and create incentives for clinicians to contribute data to HIEs.

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1. Introduction

Health information exchange (HIE) – the electronic transfer of health information among health-care organizations – has been projected to have the potential to save billions of dollars per year and significantly improve the quality of healthcare [1]. It may also be a critical component of the reforms enabled by the Affordable Care Act of 2010 including accountable care organizations and patient-centered medical homes [2, 3]. However, of more than one hundred HIEs in the United States, few are operational. Even fewer have advanced data exchange capabilities such as providing access to comprehensive data that originate from many different medical practices in the form of aggregate patient-centric records [4]. Most are focused on more basic functionality such as the delivery of laboratory results. Even if HIEs support more advanced data exchange capabilities, clinicians may not find them valuable enough to use if there are large data gaps or the interfaces are difficult to use.

Public policies may play a key role in nurturing the growth of HIEs. The American Recovery and Reinvestment Act (ARRA) of 2009 commits up to \$27 billion to stimulate the adoption of health information technology over the next several years. Participation in an HIE will be required as part of the “meaningful use” criteria for incentive payments to physicians [5]. Most of the criteria related to HIE have not yet been specified but they will be soon and official statements suggest that they will require advanced HIE functionality in the form of “access to comprehensive patient data” [6]. We found few studies, however, that have empirically assessed an operational HIE with this kind of advanced data exchange functionality [7, 8]. If the meaningful use criteria are not informed by the real-world experience of clinicians using this kind of functionality with current HIE technology, they may not result in clinicians using HIEs in ways that can realize their potential value.

To address these issues, we explored the factors that affect clinicians’ HIE usage and how clinicians value advanced data exchange functionality in a community HIE in Massachusetts that has been operational for more than two years. This HIE provides an aggregate record for each patient and encompasses most physician practices in the community. We defined usage as contributing data to the HIE and accessing data from the HIE, and we investigated the factors that affect both of these types of usage. An understanding of these factors may help to guide public policies that aim to foster HIE usage, particularly the remaining stages of the meaningful-use criteria for receiving ARRA stimulus payments.

2. Methods

2.1 Community and HIE

Northern Berkshire, a community in western Massachusetts of approximately 45,000 people, 80 physicians and one hospital, was selected as a pilot site in 2005 by the Massachusetts eHealth Collaborative to demonstrate a community-wide implementation of electronic health records (EHR) and HIE. The pilot program covered the costs of EHRs for all physician practices in the community who were willing to participate, which included almost all of the physicians, and for the construction of an HIE to allow aggregate patient records to be available for access by participating clinicians [9]. The HIE’s servers were located at the hospital and the HIE was administered by hospital staff. At the beginning of this study, which ran from October 2009 through February 2010, the HIE had been operational for more than two years.

HIE data included problem lists, medications, allergies, immunizations, procedures, social and family histories, vital signs, dates of previous physician visits and names of those physicians, laboratory results and demographic information. Textual notes were excluded from the initial phase of exchange due to privacy concerns. The included data were collected from clinicians in the community who elected to participate and from those patients who signed a consent form. Over 95% of patients opted in to allow their data to be aggregated in the HIE. Office-based clinicians had the option to link patients in their EHR to the HIE, which allowed them to access the HIE directly from their EHR without the need to search for the patient for every access. This was possible because the same vendor was used for EHRs in all of the office-based practices and for the HIE (a community decision to ease integration issues). When accessing the HIE directly from the EHR, the HIE data were displayed in a

separate pane and those data could be easily imported into the EHR. The HIE was also available to any participating clinician through a Web portal, which required the clinicians to search for the patient for each access and did not allow data to be imported into the clinicians' EHR. In this phase of the HIE implementation, the hospital did not contribute data and hospital users could only access the HIE via the Web portal.

2.2 Study participants and recruitment

In total, we interviewed 20 key informants which included 15 clinician-users, one HIE trainer, one IT staff member for the HIE, the hospital executive who supervised the HIE's operations, one director of support services for a large medical practice, and an administrative assistant for the same large medical practice. The clinician-users included 6 at the hospital, 8 at office-based practices, and one who split his time between the hospital and an office practice. Of the clinician-users interviewed, 11 were physicians. Primary care, nursing and several specialties were represented. The clinicians worked in large, medium and solo practices.

We identified these clinicians through personal contacts and HIE access logs, and then found several key informants through recommendations, the "snowball" method [10]. Because it was a small community, we believe we talked to most of the clinicians who used the HIE regularly in their practice. We did not actively seek clinicians who never used the HIE. However, we did include a few clinicians who had used it minimally but were aware of available HIE functionality.

2.3 Data collection and analysis

We used grounded theory to characterize the factors that influenced clinicians' use of HIE functionality [11]. Grounded theory involves collecting data to arrive at categories and their properties which describe and explain real-world phenomena, but does not address statistical significance of findings. In accordance with grounded theory's method of theoretical sampling, we modified and refined our questions between interviews based on the key informants' responses. We started with open-ended questions (e.g. "How do you use the HIE in your clinical practice?") followed by more focused questions to elucidate all aspects of the factors that might affect a clinician's use of the HIE. The initial set of these focused questions was derived from the authors' experience, IT adoption literature, and documented experiences of HIT and HIE [12–15]. The interviews were conducted in person (15) or over the phone (5) and most lasted one hour. One author (RR) conducted the interviews and transcribed them from recordings. All authors analyzed the content of the transcripts and helped to formulate categories. After each round of between 2 and 4 interviews, we refined the categories based on the clinicians' experience as recorded in the transcripts. We formulated the categories and their properties by consensus among the authors. When the interviews no longer resulted in new categories or properties, we assumed that we had reached "saturation" and stopped recruiting key informants, but we believe we interviewed most of the users of the HIE in the community.

3. Results

We found a wide range of usage intensity. There were many factors that affected the frequency with which clinicians accessed the HIE for information and relatively few that affected the frequency with which they contributed data to it. We grouped factors that affected accesses into two categories: motivators and moderators. Motivators are the ultimate reasons clinicians access the HIE (► Table 1). Moderators facilitate or inhibit clinicians' access of the HIE (► Table 2). To facilitate presentation of results, we organized moderators into groups as they related to patient, clinician and the HIE. We explain the factors that affect accesses, describe the range of intensities of HIE accesses found among the clinician-users, and present the factors that affect data contributions to the HIE.

3.1 Motivators of HIE accesses

Most active clinical users believed accessing the HIE helped them deliver better quality care by supplying them with relevant clinical data in a timely manner. Almost all active users of the HIE believed it had the potential to improve care even further if specific issues concerning data content and usability were addressed.

Several clinicians believed that the HIE saved them time, in part, through avoided phone calls to request clinical data from other physician offices, hospitals, pharmacies, and patients' relatives. A hospitalist believed it obviated more than 75% of such phone calls, saving him significant time. Most clinicians believed verifying a medication and allergy list was faster than creating one *de novo*. For office based EHRs, which allowed direct importing of data from the HIE, the HIE expedited documentation, especially for patients new to the practice.

Several clinicians believed that information gathered through the HIE facilitated interviews with patients and reduced the need to ask them as many questions. None of the clinicians mentioned cost as a motivating factors for accessing the HIE.

3.2 Moderators of HIE accesses: patient-related factors

Clinicians found the HIE more valuable for patients who had trouble communicating, who lacked family members to assist them, and who suffered from multiple or complex medical conditions. Emergency clinicians believed the HIE held considerable potential value to improve the efficiency by which patient information relevant to an emergency department visit could be found.

The pattern of patients' visits was also thought to be a significant moderator. For patients who only visited one practice for all their care, or who went outside of the community for care and therefore associated data would not be available in the community's self-contained HIE, clinicians had little reason to access the HIE. Conversely, for new patients with data in the system, clinicians found the HIE very valuable by saving time in gathering clinical information. Participating primary care doctors, however, may have had limited benefit in this regard because few were accepting new patients.

3.3 Moderators of HIE accesses: clinician-related factors

Many clinicians believed that their particular medical specialty determined how valuable the HIE would be. A pediatrician who used the HIE infrequently did not believe many pediatric care visits had problems with missing clinical information because consulting physicians usually forwarded their medical notes back to this clinician via fax. A psychiatrist who also accessed the HIE infrequently believed the HIE would not be valuable for his specialty because psychiatric problems do not change often and are isolated from other medical conditions. Both hospitalists interviewed, by contrast, checked the HIE (using the Web-based portal) for almost all admitted patients, partly because of their obligation to obtain complete medication lists.

The interviewed clinicians varied in how effectively they integrated HIE into their complex workflows. Even with our sample biased toward high intensity users, several physicians were unaware of how to access the HIE directly from their EHR, did not know about the ability to import data from the HIE, or simply did not think to check it to find missing patient data. Many clinicians noted that information sources they were accustomed to using "competed" with the HIE, such as a hospital portal which contained relatively complete patient data but for hospital visits only.

Extant information exchange processes using paper and fax may also have reduced the frequency with which physicians accessed the HIE. Many offices routinely faxed clinical notes to other providers in the community for referrals or in response to chart requests, decreasing the need for the HIE. Clinicians believed that specialists outside of the community were far less reliable in sending their notes but, because they were not part of the HIE, the HIE could not be used to acquire clinical information from their practices. Requesting clinical notes via fax, while more time consuming than using HIE, had the advantage of containing textual notes, which were excluded from this HIE.

How clinicians coordinated with each other within their practices also affected HIE accesses. One practice adapted their workflow so that either the physician or a nurse would routinely check the HIE

for all new patients. Another physician, by contrast, believed that it was faster to simply tell his assistant to call another office than for him to check the HIE and had not thought to ask his assistant to check the HIE instead.

Some clinicians admitted that they had a general aversion to changing their practice workflow, especially after a stressful process of installing an EHR. Time constraints, especially in primary and emergency care, also tended to reduce motivations for accessing the HIE. On the other hand, clinicians working during non-business hours found the HIE particularly valuable because other means of obtaining clinical information were unavailable.

3.4 Moderators of HIE accesses: HIE-related factors

Almost all clinicians noted and complained about gaps in the HIE's data. Textual notes were not included in the HIE for confidentiality reasons and, while many clinicians understood the privacy concerns, the lack of notes made the HIE much less valuable. For office-based clinicians, a major issue was that the hospital was not contributing any data into the HIE, severely limiting its value and necessitating clinicians to access the separate hospital portal in addition to the HIE for an adequate picture of the patient's previous care. The hospital had planned to integrate its data into the HIE but that functionality had not been completed at the time of this study.

Other data gaps were attributed to local practices that withdrew from or opted out of the HIE, including a primary care practice of several physicians, significantly reducing the amount of potentially valuable data in the HIE. For patients who did visit participating clinical practices, clinicians could not be certain why their HIE searches sometimes returned a lack of results, but they cited two possible reasons: patients occasionally refused consent, and contributing physicians sometimes did not "lock their notes" on their EHR, a software action that was required to send the clinical data into the HIE repository. Because the patient consent rate was quite high (approximately 95% of patients) the lack of timely note-locking was probably the major reason for unexpected gaps in HIE data.

In addition to completeness issues, many clinicians mentioned usability difficulties with the HIE. Hospital clinicians believed accessing the HIE through the Web portal involved "too many clicks." This was less of a problem in the office practices which were able to access the HIE more easily. Clinicians were also discouraged from using the HIE by the inability to find easily what changed since the previous visit, the requirement to change passwords frequently, and a login and search process for the Web portal that could take more than a minute yet often did not result in new or useful data.

HIE accesses were also affected by many technical difficulties such as software glitches and versioning issues with the EHRs and hardware, which resulted in frequent downtimes that lasted hours or longer, even after two years of operation.

We also asked about several other factors which were not found to moderate HIE accesses. Those who had heard of the ARRA meaningful-use payments said it had no effect on their access habits but some suggested it could become a factor. Trustworthiness was not a significant factor in accessing the HIE: all providers trusted the accuracy of the data but many would still verify it with the patient or another data source. Technical support for HIE was not found to be useful enough to them to access the HIE more frequently.

3.5 HIE access intensities

We found wide variation in clinicians' HIE access habits. The most intensive users accessed the HIE before almost every patient visit, using the HIE data as a starting point for the clinical encounter. These users included two hospitalists, one hospital nurse and one office-based pulmonologist. An office-based urologist was the next most intensive user, checking the HIE only if the patient was sent from a participating practice, which he estimated was about 40–50% of patient visits. An emergency care nurse and an office-based pediatrician checked the HIE only when they were missing information and if the primary care physician was from a participating practice, which they estimated amounted to less than 10% of visits for the nurse and less than 1% of visits for the pediatrician. Two assistants in office-based practice used the HIE for every new patient to import demographics and existing health data before the appointment. A surgeon's assistant in an office practice accessed the HIE for every patient new to the practice's database to import patient records but found data for only

about 10% of the searches for new patients. An emergency physician and a hospital nurse both tried the HIE via the Web portal many times but stopped using it because they felt it took too long and required too many clicks to access data; when they were able to access the data, they found the information largely not helpful. A pathologist used the HIE via the Web portal for about two months but found that for most samples in which the HIE might be valuable, the ordering physician had not locked their note in time, so the pathologist stopped accessing the HIE. Despite specifically trying to do so, we could not identify a primary care physician who regularly checked the HIE. One primary care doctor tried it, found it difficult to use and stopped. The psychiatrist we interviewed accessed the HIE rarely and did not often find it valuable.

3.6 Factors affecting data contribution

Data from each visit would be automatically contributed to the HIE immediately after a clinician “locked” his or her notes, which was accomplished when the clinician performed a software action that indicated the documentation for the visit was complete. Note-locking was the only way for a clinician to contribute data to the HIE. We found that note-locking was affected by the following factors: billing concerns, time constraints, and a dislike or lack of awareness of the ability to add addenda to notes. Clinicians’ note-locking habits varied considerably. One clinician compulsively locked her notes within a few hours of the patient visit. One practice adopted the policy of locking notes exactly one week after the visit to allow time for their billing department to check for errors. One primary care physician locked notes on an ad hoc basis “whenever it pops into my head.” One specialist was about 3 months behind in his notes. Another physician, after a billing error resulted in lost income, stopped locking notes altogether.

4. Discussion

Our results from investigating an operational community-wide HIE provides an early indication of how HIE capabilities may be used with a current HIE product implementation and reveals many factors that may affect clinicians’ usage of the aggregate record form of HIE. We confirmed that clinicians may derive significant benefits from accessing this form of HIE, benefits which include perceived improvements in quality of care and time savings from searching for and documenting clinical information. However, we have also found a long list of potential moderators of these benefits which, if not addressed, may result in clinicians using this form of HIE minimally or not at all. This underuse could diminish much of the potential value of an HIE. Some types of clinicians accessed the HIE much more than others, and had good reasons for doing so, suggesting that incentives targeted at providers may need to consider these factors.

We found few other studies that explicitly investigated the factors that influence HIE usage, or even reported the volumes of HIE usage for individual clinicians [8, 16]. One study mentioned two of the same moderators of HIE accesses that we found: the extent of physician participation, and existing electronic and paper processes [14]. Our results are consistent with findings from a study of the United Kingdom’s analogous HIE effort, which found an “inherent imbalance between people who must work to upload patients’ [clinical records] (general practitioners and their staff) and those who will see its benefits more directly (staff working in emergency settings)” [17]. Clinicians did not have incentives to lock their notes in a timely manner because they were not the ones who benefited directly from having those data available.

Hincapie et al studied physicians’ perceptions of an HIE in Arizona regarding its impact on health outcomes and cost, but did not specifically address factors that would affect usage [7]. That study mentions several of the motivators and moderators that we found in our study including, most notably, the lack of complete data as a barrier. This is not surprising because the HIE in that study lacked data from community ambulatory practices. Also the HIE in that study was only in operation for 3 months at the time of the study. The HIE we investigated had been operational for more than 2 years.

Vest et al attempted to determine HIE usage factors in one HIE in Texas by quantitatively analyzing how certain factors, which they derived from information management theory, affected ED phys-

ician's HIE usage as evidenced in audit logs [8]. It is difficult to assess the significance of that study because it does not report the number of HIE users or any characteristics of those users. They found that accesses of the HIE were lower during busy days, as expected. However, they also found surprising results. For example, they "noticed a degradation of usage over time" and "system usage was lower when the patient was unfamiliar to the facility." These results are difficult to interpret without qualitative research. The study by Vest et al illustrates the limitations of trying to measure quantitative relationships with only limited knowledge of context. We took the opposite approach: deriving usage factors by speaking with the users directly – the two approaches are clearly complementary.

Several studies have investigated clinicians' and provider organizations' perceptions and expectations of HIE [15, 18–22]. However, these studies are limited in that few if any of their respondents had any experience actually using HIE functionality and one is also limited to emergency physicians [18]. One moderating factor of HIE usage that we found, patient visit patterns, has been investigated by two studies but they were limited to ED or inpatient visits [23, 24].

While HIEs may vary in stakeholder composition and technical approach, most HIEs that attempt to implement advanced data exchange capabilities such as aggregate patient records will likely encounter many of the same factors affecting HIE usage that we found in this pioneering community. This is because most HIEs face the same market for technology vendors and clinicians have similar incentives for participation and usage of HIE. There is little evidence that, under current market conditions and technology sophistication, vendors will be able to address the issues that are most important for making HIEs valuable to clinicians, such as building adequate privacy functionality to allow the exchange of clinical notes with only specific providers. The HIE we studied had many technical issues even after two years of operation. More specific and widely adopted technical standards may facilitate this kind of integration to some extent but there will likely be a need for custom software for most HIE implementations [25]. HIE organizations may also have difficulty addressing underuse of HIE because of all the potential usage moderators and because they will likely have little leverage with HIE vendors to customize their products as they desire. Homegrown HIE products, while more adaptable, are expensive to construct and not possible for most communities.

5. Policy implications

To realize the potential value of HIE, clinicians, HIE and EHR product vendors and HIE trainers will need to work toward integrating HIE into clinical workflows and consider the social and technical aspects of technology adoption [26]. It is unlikely that this kind of integration will happen on a large scale without public policies that influence the factors identified in this study. Several factors of HIE usage are beyond the control of the healthcare delivery system and the influence of public policy, such as whether patients have trouble communicating their medical history. Other factors may be influenced only by fundamental reforms of clinicians' incentive structure: accountable care organizations and patient-centered medical home efforts may alter patient visit patterns and result in increased HIE usage by physicians more motivated to create complete documentation of their patients' medical history [27, 28]. Yet, these reforms may not be possible to implement without established HIEs in the first place. We did, however, find several important factors that may be amenable to public policy interventions that aim to foster HIE.

Public policies directed at clinician-users, HIE and EHR product vendors, and HIE organizations can foster HIE by addressing several of the factors that moderate HIE usage (► Table 3).

5.1 Clinician-users

Our results suggest that the absence of one large medical group such as a hospital may significantly diminish the potential value of an HIE. However, simply encouraging membership in an HIE may not be a strong enough incentive. In addition, clinicians must be required to lock their notes, or the equivalent operation, in a timely fashion so that other clinicians, and secondary applications, can benefit from their clinical documentation. Billing concerns should not prevent clinical data from being made available in an HIE. Making meaningful-use payments contingent on timely note-locking, at least for a certain proportion of notes, could make HIEs more valuable.

Creating incentives for clinicians to access an HIE may not be the best approach. Our data suggest that the frequency with which physicians access the HIE is likely to vary widely by specialty, and providers had good clinical reasons for this. Incentives for clinicians to access an HIE, therefore, should take this variation into account, including appropriate minimal requirements for frequency of access. If these minimal requirements are set too high, incentives may result in “gaming” in which the HIE is accessed solely to receive an incentive payment rather than for clinical reasons.

5.2 HIE Organizations

Currently, HIE organizations face enormous challenges, including defining their mission, satisfying various stakeholders, achieving sustainability and choosing technology vendors [4]. Discussions of usage seem to get lost amid all of these other deep concerns, though they should not. Public policies may provide HIEs with badly needed direction.

We suggest that HIEs should be more than technology providers. They should also provide HIE-related workflow services, in partnership with regional extension centers. Our results show that initial training in HIE is not enough; clinicians need help integrating HIE into their workflows. Even brief one-on-one demonstrations with clinicians of how to use the HIE after the initial trainings may increase contributions and accesses substantially. HIE organizations should be held accountable for the extent to which clinicians utilize their services.

Metrics of data contributions and accesses by clinician-users can be used as core benchmarks for assessing an HIE’s effectiveness. Monitoring metrics of data contributions will motivate HIEs to encourage and assist clinicians to lock their notes in a timely fashion, expand coverage to more patients and practices, and make patient consent processes more efficient. Monitoring metrics of HIE data accesses will motivate HIEs to help clinicians integrate HIE into their workflows, solve technology issues quickly and minimize downtimes. These metrics may provide one early step in the development of “more sophisticated measures of HIE use” [29].

Because only a small portion of the ARRA payments are available to HIEs directly, incentives for HIEs to provide workflow services may be created through other policy levers such as by requiring, as a part of HIE organizational certification or for grants, reports of HIE usage metrics or whether those metrics meet certain targets.

5.3 HIE and EHR Product Vendors

Policies that target clinicians and HIE organizations will be critically dependent on capabilities of HIE products to report relevant metrics for data contributions to the HIE and frequencies of accesses. HIE products, therefore, should be required to support these capabilities as part of conformance testing. Some such metrics may be implemented anyway, even without such a requirement, for purposes of maintaining audit trails and to facilitate HIE management and will therefore likely not be a significant burden on vendors. However, without conformance testing or a similar policy requirement, the metrics may not be standardized or accurate.

Public policy may also play an important role in shaping the market for HIE and EHR products so that they are more easily integrated and easier for clinicians to use, either through certification, conformance testing, or requirements for products to disclose the presence or absence of capabilities. HIE software is complex and many purchasing provider groups may not understand the specific features without certified definitions. Exporting clinical data into an HIE will likely be most effective if done independent of the clinician unless they clearly designate material as not to be shared. If data exchange is to depend on the physician, however, the EHR and HIE vendors could greatly facilitate the exchange by, for example, allowing clinicians the option of a “preliminary” lock that uploads clinical data to the HIE but still allows subsequent changes to the medical documentation.

Possible usability improvements which could be required for conformance testing include: a unified display of all patient data integrated with the native EHR data; an icon or other flag that indicates the HIE contains new information; the ability to automatically import data directly into an EHR; the ability to distinguish data that are new as of the previous visit; and automatic name look-up functionality to the HIE to facilitate linking patients between EHRs and HIEs. Vendors should also be

required to demonstrate which other HIE or EHR products they have already integrated with and which would require additional development.

Policies must be flexible so that they foster innovation in how HIE data are integrated into clinical workflows. For example, if a product contains a unified display that incorporates HIE data into an EHR, clinicians should not be required to access a separate portal to demonstrate that they are meaningful users of HIE. However, the EHR software should still be required to verify that the HIE data did appear on the screen for the clinician to see.

5.4 Integrating HIEs with the Direct Project

The federal government recently created the Direct Project to establish protocols for secure point-to-point communication among healthcare providers [30]. This type of communication might provide an initial step toward more advanced clinical data exchange. However, the Direct Project will not substitute for the aggregate patient record form of HIE. Aggregate patient records offer several advantages which the Direct Project does not. For example, aggregate patient records would allow clinicians to query for data rather than requiring the data to be sent to them, which is important because there will likely still be instances of missing data even if the information could be transmitted electronically using the Direct Project's protocols [31–33]. Also, there will be secondary uses of having an aggregate patient record such as quality measurement, disease registries and public health surveillance [1]. If the Direct Project protocols are well-integrated into HIEs so that clinicians can easily manage messages received via the Direct Project together with data in an HIE's aggregate patient records, the Direct Project may provide an additional incentive for clinicians to participate in an HIE by reducing the complexity of their workflows. However, if a point-to-point communication infrastructure is implemented separately from HIE organizations, it may reduce the frequency with which clinicians access HIE data because clinicians will be required to manage two separate information flows – in addition to faxes, paper mailings, and telephone calls to and from clinicians who have not yet adopted the Direct Project functionalities. Policies, should, therefore ensure that HIE organizations and the Direct Project efforts are judiciously integrated.

5.5 Limitations

This study has several limitations. We focused on the experience of one community and therefore may have overlooked factors related to HIE usage that vary by community and HIE implementation, especially because only one EHR vendor was used for all contributing providers. We had planned to study two other HIEs in Massachusetts which included multiple vendors, but both failed, underscoring the challenges of establishing the aggregate record form of HIE with multiple vendors. Communities with diverse EHR vendors may face even more technical, compatibility, and usability issues, which may suggest an even greater need for strong policy actions. Another limitation is our sample, which included only certain specialties and focused in particular on high-intensity clinician-users. Because we largely excluded clinicians who had never tried the HIE, we cannot explain why they did not even attempt use it. Finally, because clinicians may not completely understand the factors that influence them, we may have missed some factors or exaggerated others. These limitations notwithstanding, the timeline for deciding the criteria of the meaningful use payments may not allow for many further studies and it is therefore judicious to begin considering policies to address HIE usage based on these early experiences.

6. Conclusions

We found that at least some clinicians believed health information exchange improved care and saved time, which motivated them to access the HIE. However, their motivation was moderated by many factors, including the amount of data in the HIE, how well they could integrate the HIE into their workflow, and usability issues. The lack of clinical notes and absence of hospital data limited the utility of the HIE for the community in important ways. Clinicians, EHR and HIE vendors, and HIE trainers will need to work collaboratively to effectively integrate HIE into clinical workflows. Mean-

ingful-use payments can create incentives for clinicians to contribute data into HIEs, but that will likely not be enough to achieve the potential value of HIE, and complementary policies should be considered that target HIE organizations and HIE and EHR vendor companies. The goals of such complementary policies should be to make sure that HIEs are being used, and that clinicians have help in adopting HIE functionality so that they can more easily realize their benefits. Key aspects of these policies will be to create incentives for HIE organizations – coupled with regional extension centers – to provide assistance to clinicians in integrating HIE into their workflows, and to motivate HIE organizations and vendor companies to develop and report relevant metrics of usage so that efforts to foster HIE can be held accountable.

Clinical Relevance Statement

We found that many factors affected clinicians' accesses of health information exchange, including completeness of data, technical usability and how well clinicians' integrated the HIE into their workflow. If these factors are not addressed, HIE may be accessed by few clinicians. Policies should be designed to address these factors.

Conflicts of interest

The authors report no conflicts of interest.

Protection of human and animal subjects

This study was approved by the IRBs of Partners Healthcare and MIT.

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Improve patient safety and quality
<ul style="list-style-type: none"> • More complete, accurate information for medical decisions • Prevents delays in treatment • More time to spend with patients on next steps
Save clinicians time
<ul style="list-style-type: none"> • Faster arrival at verified clinical data • Faster documentation
Improve patient experience
<ul style="list-style-type: none"> • Less frustration for patients during interviews • Meets patients' expectations for efficient access to health information

Table 1
Clinicians' Motivators for HIE Access

Patient-related
<ul style="list-style-type: none"> • Patients' difficulty communicating • Presence or lack of assisting family member • Medical complexity, number of conditions, or need for active management • Acuity of patient condition • Patient visit patterns
Clinician-related
<ul style="list-style-type: none"> • Nature of medical specialty • Existing data exchange processes • Integration of HIE into workflow • Aversion to change • Time constraints • Lack of awareness of HIE functionality • Knowledge of patient's condition • Encouragement from other clinicians
HIE-related
<ul style="list-style-type: none"> • Completeness of HIE data • Technical usability of HIE • Technology dependability of HIE

Table 2
Moderators of HIE Access

Table 3 Policy options to foster clinicians' usage of HIE

Stakeholder	HIE Usage Moderator		
	Completeness of HIE data	Integration of HIE into workflow	Technical usability and dependability
Clinician-users of HIE	Meaningful-use payments for participation in HIE, timely locking of notes	Meaningful-use payments for accessing the HIE	No applicable policies
HIE organizations/ regional health IT extension centers	Monitor: number of participating practices, percent of patients consented, volume of timely data received	Monitor: HIE accesses (motivate HIE training and promotion)	Monitor: HIE accesses (motivate shorter downtimes, prudent technology selection)
HIE and EHR product vendors	Certify: "preliminary" note locking functionality, capability to report volume and timeliness of received data	Certify: capability to report HIE accesses	Certify: various features (see text)

References

1. Walker J, Pan E, Johnston D, Adler-Milstein J, Bates DW, Middleton B. The value of health care information exchange and interoperability. *Health Aff (Millwood)* 2005; Suppl Web Exclusives: W5–10–W5–18. Available from: <http://dx.doi.org/10.1377/hlthaff.w5.10>.
2. Bates DW, Bitton A. The future of health information technology in the patient-centered medical home. *Health Aff (Millwood)* 2010; 29(4): 614–621. Available from: <http://dx.doi.org/10.1377/hlthaff.2010.0007>.
3. McClellan M, McKethan AN, Lewis JL, Roski J, Fisher ES. A national strategy to put accountable care into practice. *Health Aff (Millwood)* 2010; 29(5): 982–990. Available from: <http://dx.doi.org/10.1377/hlthaff.2010.0194>.
4. Adler-Milstein J, Bates DW, Jha AK. U.S. Regional health information organizations: progress and challenges. *Health Aff (Millwood)* 2009; 28(2): 483–492. Available from: <http://dx.doi.org/10.1377/hlthaff.28.2.483>.
5. Office of the National Coordination for Health Information Technology. American Recovery and Reinvestment Act; 2009. Available from: <http://healthit.hhs.gov/>.
6. Department of Health and Human Services. Final Rule; 2010. Available from: http://www.ofr.gov/OFRUplload/OFRData/2010-17207_PL.pdf (accessed July 2010).
7. Hincapie AL, Warholak TL, Murcko AC, Slack M, Malone DC. Physicians' opinions of a health information exchange. *J Am Med Inform Assoc* 2011; 18(1): 60–65. Available from: <http://dx.doi.org/10.1136/jamia.2010.006502>.
8. Vest JR, Zhao H, Jon Jasperson, Gamm LD, Ohsfeldt RL. Factors motivating and affecting health information exchange usage. *J Am Med Inform Assoc* 2011; 18: 143–149. Available from: <http://dx.doi.org/10.1136/jamia.2010.004812>.
9. Tripathi M, Delano D, Lund B, Rudolph L. Engaging patients for health information exchange. *Health Aff (Millwood)*. 2009; 28(2): 435–443. Available from: <http://dx.doi.org/10.1377/hlthaff.28.2.435>.
10. Berg BL. Qualitative research methods for the social sciences 6th edition. Pearson; 2007.
11. Charmaz K. Constructing grounded theory: a practical guide through qualitative analysis. Sage; 2006.
12. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. *MIS Quarterly* 2003; 27: 425–478.
13. Grossman JM, Kushner KL, November EA. Creating sustainable local health information exchanges: can barriers to stakeholder participation be overcome? Center for Studying Health System Change 2008; Research brief.
14. Miller RH, Miller BS. The Santa Barbara County Care Data Exchange: what happened? *Health Aff (Millwood)* 2007; 26(5): w568–w580. Available from: <http://dx.doi.org/10.1377/hlthaff.26.5.w568>.
15. Wright A, Soran C, Jenter CA, Volk LA, Bates DW, Simon SR. Physician attitudes toward health information exchange: results of a statewide survey. *J Am Med Inform Assoc* 2010; 17(1): 66–70. Available from: <http://dx.doi.org/10.1197/jamia.M3241>.
16. Johnson KB, Gadd CS, Aronsky D, Yang K, Tang L, Estrin V, et al. The MidSouth eHealth Alliance: use and impact in the first year. *AMIA Annu Symp Proc* 2008; 333–337.
17. Greenhalgh T, Stramer K, Bratan T, Byrne E, Mohammad Y, Russell J. Introduction of shared electronic records: multi-site case study using diffusion of innovation theory. *BMJ* 2008; 337: a1786.
18. Shapiro JS, Kannry J, Kushniruk AW, Kuperman G, Subcommittee NYCENCA. Emergency physicians' perceptions of health information exchange. *J Am Med Inform Assoc* 2007; 14(6): 700–705.
19. Ross SE, Schilling LM, Fernald DH, Davidson AJ, West DR. Health information exchange in small-to-medium sized family medicine practices: motivators, barriers, and potential facilitators of adoption. *Int J Med Inform* 2010; 79(2): 123–129. Available from: <http://dx.doi.org/10.1016/j.ijmedinf.2009.12.001>.
20. Fontaine P, Zink T, Boyle RG, Kralewski J. Health information exchange: participation by Minnesota primary care practices. *Arch Intern Med* 2010; 170(7): 622–629. Available from: <http://dx.doi.org/10.1001/archinternmed.2010.54>.
21. Rudin RS, Simon SR, Volk LA, Tripathi M, Bates D. Understanding the decisions and values of stakeholders in health information exchanges: experiences from Massachusetts. *Am J Public Health* 2009; 99(5): 950–955. Available from: <http://dx.doi.org/10.2105/AJPH.2008.144873>.
22. Patel V, Abramson EL, Edwards A, Malhotra S, Kaushal R. Physicians' potential use and preferences related to health information exchange. *Int J Med Inform* 2011; 80(3): 171–180. Available from: <http://dx.doi.org/10.1016/j.ijmedinf.2010.11.008>.
23. Finnell JT, Overhage JM, Dexter PR, Perkins SM, Lane KA, McDonald CJ. Community clinical data exchange for emergency medicine patients. *AMIA Annu Symp Proc* 2003; 235–238.

24. Bourgeois FC, Olson KL, Mandl KD. Patients treated at multiple acute health care facilities: quantifying information fragmentation. *Arch Intern Med* 2010; 170(22): 1989–1995. Available from: <http://dx.doi.org/10.1001/archinternmed.2010.439>.
25. Halamka JD. Making the most of federal health information technology regulations. *Health Aff (Millwood)* 2010; 29(4): 596–600. Available from: <http://dx.doi.org/10.1377/hlthaff.2010.0232>.
26. Berg M. Patient care information systems and health care work: a sociotechnical approach. *Int J Med Inform* 1999; 55(2): 87–101.
27. Fisher ES, Staiger DO, Bynum JPW, Gottlieb DJ. Creating accountable care organizations: the extended hospital medical staff. *Health Aff (Millwood)* 2007; 26(1): w44–w57. Available from: <http://dx.doi.org/10.1377/hlthaff.26.1.w44>.
28. American Academy of Family Physicians. Joint principles of the patient-centered medical home. *Del Med J* 2008; 80(1): 21–22.
29. Vest JR, Jasperson J. What should we measure? Conceptualizing usage in health information exchange. *J Am Med Inform Assoc* 2010; 17(3): 302–307. Available from: <http://dx.doi.org/10.1136/jamia.2009.000471>.
30. The Direct Project. Available from: <http://directproject.org/> (accessed February 20, 2011).
31. Smith PC, Araya-Guerra R, Bublitz C, Parnes B, Dickinson LM, Vorst RV, et al. Missing clinical information during primary care visits. *JAMA* 2005; 293(5): 565–571. Available from: <http://dx.doi.org/10.1001/jama.293.5.565>.
32. van Walraven C, Taljaard M, Bell CM, Etchells E, Zarnke KB, Stiell IG, et al. Information exchange among physicians caring for the same patient in the community. *CMAJ*. 2008; 179(10): 1013–1018. Available from: <http://dx.doi.org/10.1503/cmaj.080430>.
33. Gandhi TK, Sittig DE, Franklin M, Sussman AJ, Fairchild DG, Bates DW. Communication breakdown in the outpatient referral process. *J Gen Intern Med* 2000; 15(9): 626–631.