

Using Information Technology to Exchange Health Information among Healthcare Providers: Measuring Usage and Understanding Value

by

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ABSTRACT

Health information exchange (HIE) – the electronic exchange of health information among healthcare institutions – has been projected to hold enormous promise as an antidote to the fragmented healthcare delivery system in the United States. After decades of mostly failed attempts, we still do not know how to make HIE work. This thesis is the beginning of a systematic understanding of HIE, focusing on the clinical users and the context in which the users and the technology interact. It uses a systems approach to understand HIE from the perspectives of the core stakeholders including healthcare providers, patients, health IT vendor companies, public policy, and the HIE organizations that supply data exchange services. The core contributions of the thesis are contained in four studies.

Values of healthcare providers as stakeholders in HIE. In a study of three communities, healthcare provider organizations were found to expect regional HIE organizations to bring them benefits from the ability to measure care quality. However, one relatively larger community placed greater value on the strategic interests of its individual provider institutions, whereas two smaller communities valued the interests of the communities as a whole.

Factors that affect clinicians' usage of HIE. In a study of clinician-users of an operational HIE, usage factors were categorized as motivators and moderators. Motivators for individual clinicians' usage of HIE included improving care quality and time savings. Moderators were numerous and included gaps in data, workflow complexity and usability issues. Several policy options and implications are discussed including: requiring HIE organizations to report metrics of HIE contributions and accesses; certifying HIE vendor companies to provide standardized usage metrics; and creating incentives for clinicians as well

as HIE organizations and regional health IT extension centers to meet HIE usage targets.

Analysis of opportunities to use HIE. In one community, 51% of visits involved “care transitions” among individual providers, and 36-41% involved care transitions between medical groups. The percentage of a provider’s visits which involved care transitions varied considerably by clinical specialty and even within specialties. Within primary care, individual clinicians’ “transition percentages” varied from 32% to 95%. This study discusses how policies designed to foster HIE usage should take this variation into account.

Analysis of mergers and provider recruitment on HIE value. In a simulation study of patient visit patterns in 10 communities, the results suggest that even after substantial consolidation of medical groups, an HIE would still have considerable value as measured by the number of opportunities for data exchange. However, in each community a small number of medical groups were key: if absent from a community HIE, these groups would reduce the value by 50%. Conversely, if they were the only groups participating, the HIE’s value would only achieve 10-20% of its value with all groups participating.

The results of these studies suggest that HIE will be needed even in the event of the expected large-scale consolidation of healthcare providers. However, efforts will be needed to recruit medical groups to join HIE organizations, to improve HIE technology, and to train clinicians to integrate HIE into their workflows.

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Chapter 1 Introduction

1.1 The landscape of health information exchange (HIE)

1.1.1 The need for HIE

In the United States, 125 million people live with chronic medical conditions. [1] Most of them receive care from multiple healthcare providers. Between 2000 and 2002, the typical Medicare beneficiary saw a median of seven different physicians, in four different offices, each year, and those with chronic conditions saw up to 16 physicians per year. [2] Within individual episodes of care for many common clinical conditions, multiple physicians are often involved. For example, a median of 8 physicians were involved in episodes of acute myocardial infarction for Medicare patients. [3] For patients such as these who are treated by multiple care-givers, coordination of care among providers is a necessity. Without care coordination, patients may receive inappropriate or harmful treatments and incur unnecessary costs of redundant diagnostic testing. [4] [5]

Unfortunately, failures in care coordination are common. [6] Primary care clinicians have reported that in more than 13% of patient visits there is missing clinical information. [7] A study of referrals found that 28% of primary care physicians and 49% of specialists were dissatisfied with the quality of information they received from each other. [4] A study of emergency room patients found that information about medical history and laboratory results were absent in almost 33% of adult visits. [8] Another group of investigators asked physicians if information from specific previous visits was available at the time of a visit and they found that information was available for only 22% of previous visits. [9]

For decades, healthcare researchers have recognized that coordination of care could be improved and wasteful costs could be reduced or eliminated through the use of information technology. [10] [11] [12] [13] [14] [15] In several reports, the Institute of Medicine has recommended that the electronic health records (EHR) of physicians should be connected together so that clinical data is shared electronically across clinical settings. This provider-provider data exchange is a significant component of what is known today as health

information exchange (HIE).^{*} [11] [12] [16] HIE has been defined as “the sharing of clinical and administrative data across the boundaries of health care institutions, health data repositories, and States.” [16] One study estimated the national cost savings for HIE at \$77.8 billion per year, of which \$13.2 billion comes from provider-provider data exchange. [14] [17]

Researchers have suggested ways to implement HIE, and a raft of HIE-related organizations and products have been launched. Most of the organizations are community-based attempts to integrate information sources from several independent provider organizations or other regional data sources such as laboratories and pharmacies.[18] [19] Researchers have described architectural strategies for these organizations along a continuum of varying degrees of integration, ranging from a completely centralized system to a federated design in which each medical practice retains control of the data it generates. [20] Other potential methods for HIE include interoperable personal health records (PHR) which would allow patients to collect and control access to their medical information. [21] [22] [23] [24] Several products have been created which aspire to serve as interoperable PHRs. [25] [26] [27]

1.1.2 The current state of HIE

Despite considerable promise, decades of research, and hundreds of pilot projects, HIE has had many failures and it is unclear if any are unalloyed successes.[28] [29] [30] [31] Of more than one hundred HIE organizations in the United States today, few have demonstrated financial sustainability and even fewer have capabilities to exchange a wide range of data and include a large population of patients. [19] Many are no longer in existence. [31] Efforts to create similar organizations in the 1990s, known as Community Health Information Networks (CHINs), have largely failed.[29] Current products aspiring to be interoperable PHRs have integrated with only a few provider organizations' EHRs and data on their adoption and usage are sparse.

Researchers have tried to understand the reasons for the slow pace of HIE diffusion. Many believe issues with technical standards inhibit HIE. [32] [33] [34] Another reason may be that only 13 percent of U.S. ambulatory physicians

^{*} This thesis uses the term HIE as a verb (the activity of exchange health information) and a noun (the organizations that facilitate exchanging health information).

use an EHR, without which participation in an HIE is possible only on a limited basis. [35] Small practices are even less likely to have EHRs and, because most providers in the U.S. work in small practices, their participation is important for HIE to succeed on a large scale. [36] Even small practices that do use EHRs have likely not joined or even plan to join HIEs, according to one study. [37]

Other reasons may include perverse incentives and market failures in the healthcare sector, most notably the fee-for-service payment system which does not pay providers for coordinating their patients' care or offset the considerable financial and workflow costs of installing an EHR. [34] Alternative payment systems, however, are problematic without rigorous measurements of healthcare quality. Unfortunately, established measures of healthcare quality address only a relatively small part of all healthcare services and experts believe that, for example, the 26 existing measures of quality developed by the Ambulatory care Quality Alliance (AQA) "may only be impacted modestly by HIE, and the major effects of HIE may fall outside of the AQA measures." [38] One study points out that "no single metric set exists for measuring the effects of EHRs and health information exchange on quality of care." [39] Established quality measures are also limited because they largely rely on administrative data, which lack important clinical information, and medical charts reviews, which cannot be done reliably and efficiently unless the medical data is maintained in standardized electronic form. This situation had led researchers to postulate that health IT is stuck in a chicken-and-egg dilemma: "[health] IT adoption is retarded by the market failure of inability to measure quality. But, to measure quality better, [health] IT must be adopted." [15]

Studies of nascent and defunct HIEs reveal additional barriers. Competition among providers for patients may create disincentives for data sharing. [29] [40] One study found that physicians and hospitals "feared losing competitive advantage by relinquishing control of 'their' data." [41] Technical issues, stakeholder politics, liability concerns regarding confidentiality, and moral hazards created by excess grant funding are thought to have contributed to the delays and demise of one prominent HIE.[31] The earlier CHIN movement is thought to have failed because of poorly conceived objectives, conflicting missions, lack of trust among stakeholders, lack of clear ownership over data systems and information, unclear financing, and the conflicting technical needs of a centralized data repository with privacy concerns.[42] While HIEs have

struggled to overcome these obstacles, other piecemeal forms of communication between providers, such as hospital-physician portals, have proliferated, possibly undermining providers' motivation to adopt the more comprehensive – but also more expensive – information services offered by HIEs. [31] [43]

Regardless of the reasons for this slow uptake, it is clear that the current state of HIE – and health IT in general – falls far short of its potential. Fortunately, healthcare leaders have taken notice of this shortfall.

1.1.3 The policy response

Policymakers in both major U.S. political parties have recognized the importance of expanding EHRs and HIE. In 2005 Newt Gingrich supported a bill introduced by Hillary Clinton that promoted federal grants to regional efforts that support HIE, reflecting clear bipartisan agreement. [44] When President Obama assumed office, he continued support of the Office of the National Coordinator for Health IT (ONC), an office within the Department of Health and Human Services (DHHS) that was created under former President George W. Bush in 2004. For its first few years ONC began harmonizing technical standards, creating a framework for a national health information network, establishing privacy and security policies, and certifying vendors' EHR products based on their functional capabilities.

Then, in what is perhaps the most significant policy breakthrough in the history of health IT, the American Recovery and Reinvestment Act (ARRA) of 2009 designated approximately \$27 billion in incentive payments for clinicians to adopt EHRs and HIE and additional funding to establish regional health IT extension centers. [45] The incentive payments will be made to healthcare providers who demonstrate “meaningful use” of health information technologies. The extension centers will support clinicians as they adopt the health IT systems to qualify for the meaningful use payments. The legislation specifies that the criteria used to measure meaningful use are decided by a federal policy committee. The payments will be made in three stages in years 2011 (stage 1), 2013 (stage 2) and 2015 (stage 3) and the criteria will expand with each stage. ARRA specifies that physicians who still do not meet the meaningful-use criteria after the payment period expires will find their Medicare reimbursements begin to decline, adding teeth to the incentives.

Policymakers have recently finalized the stage 1 criteria [46] [47] The proposed goals of stage 1 include “electronically capturing health information in a coded format; using that information to track key clinical conditions and communicating that information for care coordination purposes (whether that information is structured or unstructured, but in structured format whenever feasible).” [48] Specific measures for stage 1 require eligible providers to “perform at least one test of their EHRs capacity to electronically exchange information.” Several other stage 1 measures, such as those requiring that a “summary of care record is provided for more than 50% of patient transitions or referrals” and “more than 10% of patients are provided electronic access to information within 4 days of its being updated in the EHR,” may also nurture the growth of HIEs or interoperable PHRs. Policymakers have also issued guidelines for stages 2 and 3 which indicate stronger HIE requirements. Stage 2 will require “the exchange of information in the most structured format possible” and stage 3 will focus on “access to comprehensive patient data.”

As part of the meaningful use criteria, policymakers are considering requiring the use of standard protocols that allow secure point-to-point communication between clinicians. ONC is sponsoring the development of these protocols in a project called the Nationwide Health Information Network Direct (recently renamed the “Direct Project”). [49] [50] These protocols, however, would provide only a limited form of HIE and, if included, would likely be only one component of the HIE-related meaningful use criteria. More advanced forms of HIE, that involve creating aggregate patients records – longitudinal records of patients’ health information aggregated from multiple clinical sources – will probably be required also.

The ARRA meaningful use payments are different from previous attempts to promote health IT. While other projects have funded health IT for providers in specific locations, ARRA’s direct incentives apply to most providers in the country, dwarfing the scope of even the largest previous initiatives which were mostly at the state or regional level. [19] [51] Also, whereas prior projects issued grants to providers for the purchase of health IT systems or expected the providers to pay the bulk of the costs themselves, ARRA has introduced the concept of “meaningful use” of these systems as a condition for receiving payment. These aspects of the ARRA payments may help to motivate enough providers to adopt

EHRs and HIE so that the chicken-and-egg dilemma and other barriers to health IT adoption are finally overcome.

In March of 2010, the landscape for HIE was altered once again with the passage of the Patient Protection and Affordable Care Act (PPACA). While much of this legislation does not directly bear upon HIE, some of the reform programs it will initiate may result in fundamental changes to the incentive environment of healthcare providers, which may increase their motivation to adopt and use HIE. Conversely, HIE may enable some of these reforms to succeed, by allowing more efficient information gathering and improvements in healthcare quality measurement. (See chapter 6.) These large-scale policy movements may finally make HIE a reality after decades of stalled progress. However, important decisions regarding the criteria for receiving meaningful use payments and the scope and responsibilities of HIE organizations have not yet been made, decisions which will likely prove pivotal to HIE success.

1.2 Evaluating HIE

Even before ARRA was enacted, researchers had taken a strong interest in evaluating HIE projects. [38] Rigorous evaluation of HIE is important because it enables HIE organizations to demonstrate value to their stakeholders and allows policymakers and researchers to compare projects and generalize across regions. [52] With the enactment of ARRA, HIE evaluation takes on even more importance by potentially informing stages 2 and 3 of the meaningful use criteria and other public policies that might shape the priorities of HIE organizations and the new health IT extension centers. With the enactment of Patient Protection and Affordable Care Act of 2010, HIE evaluations may also have implications for the new projects called for in that legislation which will likely depend on HIE, such as accountable care organizations and patient-centered medical homes. [53] [54]

One metric that can be used for evaluating an HIE is the degree to which its business model is sustainable and does not rely upon external grants or donations. [55] The rationale behind this metric is that if stakeholders are willing to pay for an HIE's services, those services must be creating value for the

stakeholders. This would only be true if the HIE services are not bundled with other non-HIE services and if the providers were paying the fees voluntarily, not because of a regulatory or external incentive requirement. Surveys show that almost all HIEs relied on grants initially, and most still do, but a few have achieved sustainability. [18] [19] A survey of physicians in Massachusetts found that while most expected that HIE would reduce costs, improve quality, and save them time, only 54% said they would pay an unspecified monthly fee for the service and only 37% were willing to pay \$150 per month for HIE, which may be the approximate fee that HIEs will charge. [56] Because relatively few of these physicians had experience using an HIE, many may change their attitudes once HIE becomes available in their communities. Therefore, it is not clear if most HIEs will ever be able to achieve financial sustainability and other measures of value will likely be needed.

Even if most HIEs could reach sustainability, a sustainable business model is not a sufficient condition for considering an HIE as a success. Many of the HIEs that are financially sustainability are based on the delivery of laboratory results rather than the provider-provider data exchanges that will help improve care coordination but also require higher costs to design, install, and operate.[19] Therefore, further evaluation will be needed even for HIEs that are financially sustainable.

Some researchers have argued that a sustainable business model is not even necessary for HIE success, and that HIEs should operate as public utilities. [28] [57] Anticipated secondary benefits from HIE, such as disease surveillance and quality reporting, support this argument. [58] However, a public utility model may run the risk of the HIE users having no “skin in the game.” If the clinician-users are not voluntarily paying for unbundled HIE services, further evaluation becomes even more important to demonstrate value. This point is important for policymakers to consider when deciding the remaining criteria for the meaningful use payments. Setting the criteria so that providers are merely required to join an HIE and pay the fee will not be enough to ensure that HIEs create value.

One way to improve the prospects for HIEs to create value and achieve sustainability is by better understanding the “needs, expectations and motivations of the many different stakeholders.” [59] This kind of understanding may allow HIEs and policymakers to take into account stakeholder values that

had not been previously understood. However, few such investigations have been done. Experts have suggested using qualitative methods for these kinds of evaluations so that important contextual factors are considered.

An important part of HIE evaluation is demonstrating its clinical and financial benefits. Several studies have attempted this kind of evaluation, but few have succeeded in demonstrating the magnitude of benefits that researchers expect HIE to provide. [38] [52] One pilot randomized controlled trial of data sharing in regional emergency departments (ED) found a savings of \$26 per encounter in one site, but the study did not find any savings in a second site and could not prove that HIE had an effect on clinical quality measures. [60] The implications of this study may be limited, however, because the data sharing was done primarily through paper, electronic usage was found to be minimal, and the clinical data originated from only one institution. Another study evaluating an electronic link between EDs and family physicians did not find that the intervention resulted in a reduction in resource utilization. [61] A third study analyzed the HIE accesses of clinicians who treated a cohort of uninsured patients and hypothesized that HIE usage would result in decreased volumes of ED visits by those patients. That study failed to prove its hypothesis. [62] Because the clinical and financial benefits of HIE have not yet been convincingly demonstrated, models estimating HIE value have relied on expert opinion and excluded significant sources of potential value. [14]

It is important for researchers to continue to search for ways to demonstrate the benefits of HIE. However, several prominent experts have suggested that not all evaluations need to be done on every project and “a rigorous evaluation of the quality impact of an HIE intervention may only need to be done three times if the results are consistent.” [38] These experts point out that studies of quality improvements and health outcomes are the most difficult and require a large controlled trial. They suggest that after these studies have been done, “confirmation that process variables are improving may serve as sufficient evidence that the HIE project is clinically successful.”

One such process variable is usage. [38] [55] A study of decision support systems (not related to HIE) demonstrated that voluntary usage of information technologies has been correlated with improvements in organizational performance. [63] That study concludes that “the ability to capture and model

the actual usage of technology may be key in assessing the relationship between implementing information technologies and benefits or payoffs results from them." Measurements of HIE usage might therefore prove to be reasonable approximations of an HIE's value, even absent rigorous evidence of clinical and financial benefits.

A few studies have reported measurements related to HIE usage. A 2003 study of visits to ED in Indianapolis found that 7.6% of ED patients visit more than one of the five hospital systems, and those patients account for 19% of the total visits, which may be an estimate of the portion of potential data exchanges between those EDs. [64] A 2004 study of electronic data interchange usage in Beijing's hospitals reported usage values, but these data included non-clinical document exchanges and therefore are difficult to interpret in terms of HIE. [65] A 2008 symposium article about the MidSouth eHealth Alliance, an HIE in Tennessee, looked at HIE use in five EDs and reported that the HIE was accessed in approximately 3% of all visits and 10% of visits in which recent data from another site was available. [66] A 2009 study of an HIE in Texas that was limited to uninsured patients in specific clinics, and a subset of medical information, reported that more than 56% of individuals had information accessed in the HIE. [62] However, that study did not report counts of HIE accesses or patient visits. A 2010 paper reviewed the academic literature on HIE usage and related concepts for implications on the ARRA meaningful use payments. [67] Another recent study, in December 2010, found that of adult who visited acute care facilities in Massachusetts within a five year study period 31% of patients visited 2 or more hospitals during that period accounting for 56.5% of all acute care visits, and 1% of those patients visited 5 or more hospitals.[68] None of these studies show how measurements of HIE usage can be used in the design and operation of an HIE organization or to guide public policy to promote or evaluate HIE projects.

1.3 Thesis goals and outline

This thesis provides a deeper understanding of HIE by evaluating geographical communities in which HIEs have been planned and one in which an HIE is operational. Using qualitative methods, it uncovers clinicians' values

related to HIE. Using quantitative methods, it shows how metrics related to HIE usage can be used to create incentives for increasing HIE usage and can assess the value and robustness of HIE projects. Policymakers and HIE organizations can use the results of this research to help build and manage HIEs so that they realize their potential to improve the quality and efficiency of healthcare.

In particular, this thesis asks four questions:

Question 1: What are the values of healthcare provider organizations as stakeholders in HIE?

Question 2: What factors affect clinicians' usage of health information exchange?

Question 3: What is the potential value of HIE as measured by "care transitions?"

Question 4: How do mergers and variation of provider participation affect an HIE's potential value?

The Chapter 2 addresses the first question by introducing several HIE demonstration pilots and identifying some of the needs, expectations and motivations of the participating healthcare providers related to HIE. We use qualitative methods to discover these values by probing the reasons for the providers' choice of technical architecture in their community HIEs. Our findings suggest that providers' motivations and expectations for HIE may depend on the size of the community and the organizational structure of its providers; larger communities with many provider organizations may find more difficulty acting in the strategic interest of the community as a whole when implementing HIE.

Chapter 3 addresses the second question by shifting focus from decisions made by the communities as a whole to the values of individual clinician-users of HIE for one of the pilot communities. We interview 22 clinicians and HIE staff and identify factors that affect the clinicians' usage of the available HIE product. We find several factors that motivate clinicians to use HIE and a long list of factors that could moderate their usage. We then offer recommendations to policymakers, HIE organizations and HIE vendor companies to account for these factors. Many of our recommendations involve using measurements of HIE usage.

In chapter 4, we address the third question and propose a way to estimate potential HIE usage based on patient care transitions and calculate these measurements in one community that has an operational HIE. Our findings suggest that potential usage varies considerably across different clinicians and

clinical specialties within this community and, therefore, this variation should be taken into account when designing and evaluating HIEs.

Chapter 5 addressed the final question by applying the same measurements of potential usage based on care transitions that we used in chapter 4 to simulate how changes in an HIE's composition of healthcare provider organizations may impact the potential usage of an HIE. We investigate compositional variation in terms of scenarios of provider participation and scenarios of provider consolidation. Using administrative claims data from 10 geographic communities, we simulate these scenarios using actual patient visits patterns.

Developments in HIE are happening at the same time as other substantial changes in the healthcare system. Chapter 6 analyzes which of these many possible changes might impact HIE and vice versa. A significant part of this chapter is devoted to investigating the relationships between HIE and programs created by the Patient Protection and Affordable Care Act of 2010.

Finally Chapter 7 summarizes key contributions and recommendations and offers suggestions for future research.

Chapter 2 Healthcare providers' decisions and values for HIE: experiences from three communities

2.1 Prologue

This research in this chapter was conducted in 2007 and it reflects the current knowledge at that time. Recent policy developments, such as the meaningful use payments, are not mentioned except in the chapter epilogue, which discusses the implications of this research in light of current policy.

2.2 Abstract

Despite the widely held expectation that health information exchange (HIE) will improve healthcare, few examples of sustainable HIEs exist. To learn how HIEs are established, we examined the needs, expectations and motivations of key HIE stakeholders in three Massachusetts communities, by probing their decision-making processes in selecting technical architectures for HIE. All three eventually selected a hybrid architecture, which includes a central data repository. Our findings suggest that to support sustainability in the long term, HIE efforts must foster trust, appeal to strategic interests, and meet stakeholder expectations of benefits from quality measurements. *

2.3 Introduction

According to one leader in HIE, "We desperately need, efficiently and expeditiously, to learn what works and what doesn't." [69] Learning "what works and what doesn't" in the realm of HIE is challenging not only because of the dearth of successful models but also because knowledge of stakeholder needs, expectations and motivations regarding HIE is severely lacking. [59] One way to

* The research in this chapter was published here: 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

better understand these stakeholder characteristics is to investigate qualitatively the factors that community members considered in selecting the organization and technical architecture of their HIE.

When the stakeholders make these decisions, their individual and collective values emerge implicitly and explicitly. Decisions of technical architecture can therefore be viewed, in economists' terms, as "revealed preferences." The final decisions and the reasons behind them provide a revealing window into the stakeholders' perspective, bringing the complex dynamics of creating an HIE into sharper focus and allowing us to infer the factors that may help HIEs create value for their stakeholders and inform public policies.

To gain insight, we conducted an evaluation of the Massachusetts eHealth Collaborative (www.maehc.org), an organization overseeing the implementation of HIE in three Massachusetts communities, each of which had representatives choose their respective HIE technical architectures. For each of the three communities, we investigated how the following eight factors influenced the decision-making about the structure and technical architectural of their HIE: security, cost, complexity of implementation, performance, ability to measure quality of care, strategic goals, level of trust in the community, and stakeholders' desire for independence.

2.4 Study methods

2.4.1 Overview

The Massachusetts eHealth Collaborative ("the Collaborative") was formed in 2004, funded by a grant from Blue Cross and Blue Shield of Massachusetts to promote the adoption of electronic health records (EHRs) and HIE.* [6] Through a request for proposals (RFP) process, the Collaborative chose three communities in Massachusetts in which it planned to supply every physician with an EHR and each community with HIE capabilities so that patient health data could be electronically transferred among independent practices. The chosen communities

* Massachusetts eHealth Collaborative website contains RFPs and other relevant documents. www.maehc.org (10 March 2008).

were Northern Berkshire, Greater Newburyport and Greater Brockton. The Collaborative has covered all financial costs of the EHRs and HIE for several years. The HIE products are currently being installed in the communities and customized by the vendor companies chosen to implement each community's HIE architecture, representing the culmination of an arduous process of selecting vendors and technical architectures that occurred mostly in the summer of 2006. During that time, Collaborative staff and community steering committees worked together to choose the architecture and vendor that best met each community's requirements.

2.4.2 Information sources

We conducted semi-structured interviews with members of the Collaborative and with leadership from the three individual communities. We also reviewed documentation that was used in the process of selecting vendors and the specific HIE architectures. The interviews focused on drawing out the factors deemed by the communities to be most critical in the selection of the overall structure and technical architecture of the HIE. To provide context for the decisions, we also asked about the processes employed by the decision-makers.

2.5 Results

We interviewed 14 key informants in the summer and fall of 2007, approximately 12 months after their technical architecture decisions were made and just prior to the completion of their HIE implementation. From these interviews and relevant documentation, we found that three general architectures were considered by each community. The process of selecting between the architectures occurred over a period of several months, with the first part of the process - establishing general guidelines and structure for the HIE - common to all communities and driven by the Collaborative, and continuing with each individual community making its own decisions about the specific features of the HIE and the vendor to provide the system and services based on its own criteria. The twin decisions of selecting a vendor and selecting a technical architecture were found to be tightly linked and considered simultaneously by

each community. The final decisions for selecting technical architectures involved the consideration of many factors.

2.5.1 Technical architectures

Three general architectural alternatives were considered by the communities: fully centralized, peer-to-peer (P2P) and hybrid. (See table 1.1) These alternatives describe the physical storage location of clinical data and the way data are shared among the members of the HIE network. While the distinction between these architectures may seem relatively unimportant, the choice actually has many implications which include the balance between privacy and ability to measure quality, which may affect likelihood of the HIE's success and has important policy implications.

A fully centralized architecture stores all clinical data in one central repository; no data are stored locally in physician offices. All clinical data stored in the EHR would be shareable between community physicians. This architecture is essentially a fully integrated EHR similar to what can be found in a unified organization such as the Veterans Health Administration.

Opposite of the fully centralized architecture, the P2P approach – often called a “federated” model - contains no centralized repository. Rather, clinical data are stored at the physician practice that generated the data. Data exchanges occur when a physician or other authorized healthcare provider sends a query for a particular patient and then receives responses to the query from any practices within the HIE network that have data on the patient. This architecture requires physician practices to host and maintain data repositories as well as servers that can access the repositories and respond to queries.

A hybrid architecture combines aspects of both the fully centralized and P2P approaches. It uses a centralized repository but the repository is only a copy of a portion of the data that are stored locally at each physician practice so that physicians can still manage their own EHRs as they do in the P2P approach. Each individual EHR “pushes” designated data elements of new patient data to the centralized repository which can then be read by other community physicians. Unlike the P2P approach, network-wide queries are unnecessary in the hybrid approach and are replaced by direct accesses to the centralized repository from any physician in the HIE network rendering the hybrid approach faster than P2P.

Other architectures beyond these three options are possible but were not seriously considered by any of the communities.*

	Fully centralized	Peer-to-peer	Hybrid
Centralized repository	Yes	No	Yes
Patient data stored in physician's office	No	Yes	Yes
Servers hosted in physician's office	No	Yes	No
Requires querying network of servers for clinical data	No	Yes	No

Table 2.1: HIE Technical Architectures

2.5.2 Selection process and final decisions

Although each community ultimately made its own decision, the Collaborative organization guided much of the process by working with physician councils and privacy and security councils, and by educating the community steering committees. Engaging these stakeholder groups resulted in broad support in the communities for the selection process and final decisions. The Collaborative began this process of selecting a company or companies to install and manage the HIEs by issuing an RFP and then scrutinized the potential vendors that submitted proposals. The community of Northern Berkshire, for reasons described in the next section, did not participate in this vendor selection process. The RFP required a detailed description of the vendor's technical architecture solutions, privacy and security technology, integration and interface approaches, cost information and a timeline for implementation.⁺ None of the vendors had a fully developed solution that could accommodate each of the three different HIE technical architectures without additional development. The choice of technical architecture, therefore, would be constrained by the chosen

* A description of technical architectures can be found at the eHealth Initiative website. toolkit.ehealthinitiative.org/technology/principlesaddendum4.msp (1 March 2008).

⁺ The RFP is available at the Collaborative Website at www.maehc.org; to promote interoperability, all EHR products supported by the Collaborative are certified by the Certification Commission for Health Information Technology and the HIE vendor is expected to comply with technical specifications from MA-SHARE. www.mahealthdata.org/ma-share/ (1 March 2008).

vendor's software development capacity. Hence, vendor and architecture selection were tightly linked and considered simultaneously.

Respondents to the RFP included approximately 17 vendor companies among which 10 were seriously considered on the basis of cost and technical appropriateness of the proposals. The Collaborative Board identified a task force of members to oversee the HIE vendor selection process. This task force decided that the communities would not be given any cost information except estimates of what they would have to pay after the Collaborative pilot ended. This approach would (1) avoid biasing the communities into thinking the more expensive products were better [70] and (2) prevent proprietary vendor cost information from being circulated. The 10 vendor applications were presented to a technology review committee.

The technology review committee consisted of 20 technology experts from a wide variety of healthcare organizations, members from each pilot community and representatives from the Collaborative staff. Making decisions based on consensus, this committee winnowed the RFP respondents from 10 to six and then, with broader community participation, narrowed it down further to four finalist companies, which were invited to give presentations and demonstrations. Each of the three communities' experiences with the final selection process were slightly different.

Northern Berkshire. A small community in the Berkshire Mountains of western Massachusetts with roughly 15 physician practices, Northern Berkshire settled on a vendor and technical architecture without extensive debate. This community had agreed to adopt the same EHR vendor for every physician practice in the community and it was therefore sensible to have that same vendor provide the HIE product, obviating this community's participation in the RFP described above. The vendor had been selected with the assurance that it could implement the community's architecture of choice: the hybrid approach.

Greater Newburyport. By all accounts, Newburyport's decision for a technical architecture, a hybrid approach, was obvious and unanimous because of its goal of measuring quality of care, but choosing a vendor proved more challenging. Multiple vendors were deemed acceptable and none stood out as a clearly superior. Factoring in not only technological capabilities and company experience with HIE but also how well the vendor would be able to interact with the community during the intensive installation and customization process, the

decision was finally resolved when Brockton – the largest of the communities - settled on a vendor which was also one of the finalists for Newburyport. Most people in the project felt that having one vendor provide HIE for both communities would ease or avoid implementation challenges compared with using two different vendors.

Greater Brockton. Whereas Northern Berkshire and Newburyport settled on their technical architecture early, Brockton - a community with a diffuse and competitive healthcare milieu formed out of six large provider institutions and many smaller physician offices - deliberated the architecture question extensively. The Brockton steering committee iteratively narrowed down the vendors to two finalists based on criteria similar to those used in Newburyport: technology capabilities, experience in HIE, and ability to work with the community. The winning vendor was chosen in part because it claimed to be capable of developing and implementing whatever technical architecture on which Brockton would eventually settle. Initially leaning strongly toward the P2P approach, after substantial deliberation the community eventually selected the same architecture as the other two communities: the hybrid approach.

Thus, all communities chose the hybrid approach. However, reasons for the decision varied across the communities.

2.5.3 Factors

All of the eight factors we investigated were considered by the communities except cost because the Collaborative paid the HIE construction fees and ongoing costs for the different architecture were either not determined or the same across architectures.

Performance. Performance concerns for the P2P approach existed in all communities. Integrating HIE into clinical workflows was expected to be challenging even with very high performance. The expected delays of P2P could exacerbate the workflow challenges and impair usability, resulting in slower adoption of the HIE functionalities, especially in rural Northern Berkshire where some providers had slower internet connections.

Complexity. The relatively high complexity of P2P was expected to delay implementation of the HIE, particularly in Brockton. That community's selected vendor emphasized the technical complexities and difficulties of implementing

P2P, which would involve over 50 servers (one in each practice), and argued for the hybrid approach.

Security. Security was paramount to all communities but the steering committees in Northern Berkshire and Newburyport did not view any architecture as possessing inherently superior security. However, in Northern Berkshire steering committee members felt that by establishing a rule that no physician's EHR would ever accept any queries but only "push" the data to another location, some "gut-level" security would be created. This rule eliminated the P2P approach. Initially, Brockton thought P2P would be more secure because each organization would be managing its own data, avoiding the establishment of a large centralized repository of patient data. After further consideration, their view on security reversed. Security for a centralized repository was thought to be more robust compared with relying on the 50 servers of a P2P approach, each of which would need to be secured individually. Furthermore, focus groups found that patients did not view a centralized repository of health information as an inherent security risk. Also, some steering committee members speculated that a centralized repository would allow liability for security breaches to be transferred from the individual providers to the centralized host, easing the burden on providers.

Measuring quality of care. All communities were very motivated to use the HIE for measuring quality of care and analysis which, they reasoned, would be more easily accomplished through a hybrid approach compared to P2P, because only a centralized repository would yield sufficient efficiency. Newburyport is unique among the Collaborative communities in that its physicians and hospital do collective contracting and pay-for-performance quality programs under a single organization, the Lower Merrimac Valley Physician Hospital Organization. Newburyport viewed the HIE as an opportunity to strengthen this organization's care improvement and negotiating capabilities. Brockton, unlike the other communities, had not emphasized community-wide quality analysis. Rather, this community was more interested in quality measurements for individual organizations. Community-wide quality programs were discussed but not an important factor in the decision. Still, the ability to do quality analysis across the sites of an individual organization favored a hybrid approach. All communities hoped that the ability to measure quality of care would allow for the creation of

more value-added programs such as referral management and patient matching with community specialists.

Strategic goals. All communities made the architecture decisions to align with their strategic goals. The goal of improving healthcare quality was found in every community. Additionally, Newburyport's community strategy included providing more patient-centric care through a patient portal for which the centralized repository of the hybrid model was viewed as more conducive than P2P.

In Brockton, individual provider institutions initially argued for the P2P approach in support of their strategic goals in an interesting way: at least one of the larger provider organizations considered utilizing the community HIE to integrate their own network of providers thereby helping the provider organization achieve its corporate goals. The organization could still build a redundant data exchange infrastructure, but having the HIE solve this problem would save costs. Under this arrangement, although the organization would want to utilize the service of the HIE, it would also want to avoid undue dependence on an external organization. A P2P approach was perceived to represent less dependence on the community compared with a hybrid approach because if the institution were to separate from the community HIE, it could still leverage the P2P exchange mechanism. This contrasts with the hybrid approach which would bind the institution's integration plan to the community project.

The hybrid approach, however, also had strategic advantages which could help both the individual institutions – through quality measurements - and the community. The community could potentially benefit from the technical architecture's scalability. If neighboring communities would be willing to pay a fee to access Brockton's HIE, expanding to those communities could help achieve sustainability. The hybrid approach was decidedly more scalable than P2P which would involve more complexity and decreased performance with each additional node.

Unlike Newburyport, a patient portal was not a part of Brockton's architectural decision or community strategy. One Brockton community leader called the patient portal functionality "icing on the cake." Brockton has yet to decide if a community-wide portal will be implemented or if each institution will offer its own.

Trust. The communities varied in their level of trust among physician practices at the start of the pilot, but in all communities trust seemed to increase as a result of their participation in their HIEs. Northern Berkshire and Newburyport had strong bonds of trust from the outset which continued into the project. Because of this level trust in Northern Berkshire, HIE participants allowed the data repository to be located at the local hospital. At the start of the pilot, Brockton's healthcare providers, despite having a history of competition, informally agreed not use technology to compete inside the community for patients. That agreement formed the basis of more trusting relationships within the community's network of healthcare providers. A sufficient level of trust was achieved in Brockton to allow for the creation of a shared centralized repository. Also, because of these bonds of trust, all participating providers were willing to make their patients' data available for the HIE, data which are considered by some healthcare providers in the country to be a competitive asset. [15] Plans in every community to have clear policies and procedures for data access, which included monitoring and sanctions, also increased trust and willingness to exchange data.

Desire for independence. Despite a relatively high level of trust in Northern Berkshire and Newburyport and a growing trust in Brockton, a completely centralized approach was never seriously considered in any community because the physicians wanted to operate their EHRs independent of a centralized organization. Northern Berkshire briefly considered a completely centralized approach but ultimately decided against it because it would have involved commingling patient data from different physician practices which are separate legal entities. For that same reason, the Collaborative would have disallowed a centralized repository even if it was favored by a community.

In summary, Northern Berkshire's selection was influenced primarily by performance and the ability to measure quality of care. In Newburyport, the ability to measure quality of care and creating a working patient portal were the dominating factors. Brockton's deliberations involved almost every one of the factors we investigated but, in the end, the ability to measure quality of care and potential for future sustainability favored the hybrid approach. Every community was found to have gained considerable trust as a result of participation in the Collaborative pilot.

2.6 Discussion

All three communities selected the hybrid approach for an HIE technical architecture. However, the three communities differed somewhat in the reasons behind their selections. Choosing a technical architecture for HIE was much more than a question of optimizing technical variables; rather, it was deeply connected to the values of the key stakeholders in their particular circumstances. Because in every community, every willing healthcare provider received an EHR, was invited to participate in the HIE, and had representation on the steering committee, each community's technical architecture decision is likely to reflect the values of the entire community. In contrast, many RHIOs begin as a small number of large institutions that design the infrastructure without involvement from local providers to which they may expand. This study, therefore, may better illuminate the values of communities and the factors they consider when embarking on HIE, though it may not be representative of organic RHIO development in other communities.

Two other studies also use qualitative methods to evaluate specific HIEs. A study on the Santa Barbara County Care Data Exchange is a detailed history which includes the reasons for that project's demise, claiming that the experience "illustrates the danger that in some communities, unfavorable short-term private value propositions for simple HIE services may delay more advanced HIE services with greater potential medium- and long-term private/societal payoff." [31] By elucidating the perspectives of key stakeholders, our study advances this discussion of value propositions and leads to identifying those that may be favorable in the short- and long-term.

A case study on the Indiana HIE describes a working HIE which consists of five health systems but only some of the office practices in the community. [30] In contrast to the current study, it describes how to build an HIE organically without the inclusion of all community practices, and does not directly address expectations, needs, and motivations of key stakeholders.

The reasoning of the stakeholders surrounding many of the factors – some of which were found to be related - offers a view into their perspective. Security, while a strong concern, was not found to be a major barrier to HIE. However, a significant level of trust between the community stakeholders and by

patients with respect to the security of their data was requisite. Stakeholders' desire for independence was also not a major barrier to HIE, but a significant level of trust was also needed for this to be true. That trust was found to be important is not surprising. Social capital, for which trust is an important component, has been recognized as the "primary foundation for an HIE." [71] Performance was found to be important in its effect on workflow, showing that healthcare providers are very concerned about how to integrate the HIE into their daily routines.

Finally, each community had different strategic goals. Important to Newburyport's strategy was a patient portal. Some Brockton providers planned to use the HIE to address their own corporate goals. All communities identified the ability to measure quality as a strategic goal, but differences were found in that Northern Berkshire and Newburyport expected community-wide quality measurements and Brockton expected measurements principally for individual providers and institutions.

While none of the communities chose to adopt a single EHR for multiple practices because of legal concerns, an EHR may be designed to address these concerns by labeling patients data with the practice name from which it originated. However, many providers may want to retain flexibility in their IT investments and refuse to share EHR resources with providers in different practices.

Our findings and analysis demonstrate that examining the technical architecture decisions for HIEs can illuminate many of the needs, expectations and motivations of stakeholders.

2.7 Policy implications

This study found that the perspectives of key HIE stakeholders centered on three aspects: level of trust, strategic interests, and benefits from quality measurements. How effectively an HIE addresses these aspects may largely determine its ability to become established and achieve long-term success. "What are the levels of trust among the stakeholder group and what are the conditions and issues that affect this trust?" asks one study. [59] The experience of the Collaborative communities supports the argument that trust is a critical

factor in the construction of HIEs and suggests that trust can be created in a community through participation in a community-wide HIE effort. This is particularly evident in Brockton, probably the community most representative of the US healthcare system because of its large, diffuse, and competitive healthcare market. Brockton's experience is a positive sign that competing providers may be able to collaborate for the sake of the community in certain circumstances. The willingness of providers to have their patients' data exchanged in the HIE rather than treating the data as a competitive asset is another optimistic sign that trust can be created in a community. However, receiving a grant of the EHRs and HIE infrastructure may have been necessary for this trust to develop.

Trust is necessary for establishing an HIE, but it is not sufficient. A study of the factors that contribute to efficient and successful use of IT in various industries recommends that the government should "make policy decisions that turn [healthcare] IT into a competitive weapon." [15] This implies that to be successful and sustainable, HIEs must appeal to stakeholders' strategic interests. The experiences of the Collaborative pilot communities suggest how appealing to the strategic interests of individual healthcare providers as well as those of the communities as a whole can be accomplished.

Participating in the HIE may become competitively advantageous to the individual providers through administrative savings and by retaining existing patients and attracting new patients. Despite Brockton's informal agreement not to use technology to compete inside the community, if patients recognize the value of the HIE, it will be in providers' strategic interests to continue participating. The experience of the Indiana HIE shows that benefits of administrative savings can also motivate continued participation. [30] Because the value of the HIE increases with increased membership – a phenomenon called a "network externality" – the strong incentive to continue participating in the HIE is contingent upon having a critical mass of participants. [72] By engaging entire communities, the Collaborative pilot communities have undoubtedly exceeded the critical mass needed to make participation in the HIE a competitive advantage. For an HIE that grows more organically, it is not clear when this critical point may be reached.

Although appealing to the strategies of individual stakeholders will be important to strengthen their engagement, it is likely to be community strategies

that will be crucial for sustainability. HIE may even be used to attract new patients to the community and to retain them. HIE would therefore be a competitive weapon for the community as a whole. Our findings suggest that the size of a community will likely affect its propensity for acting in the community's strategic interests - and very large and expansive communities in particular may have difficulty working together.

Several studies argue that the presence of a diverse set of proprietary exchange projects such as hospital-physician portals could thwart efforts to establish HIEs by lessening the comparative benefits of a community HIE. [41] [73] [43] The reasons the communities in this study have not found this to be a barrier are probably that the benefits of receiving EHRs and HIE at no charge outweighed competitive goals of individual institutions and that few data exchange agreements were in place when the project began.

This study suggests that HIE success may also depend, in part, on how effectively quality measurement is addressed. Quality measurements might motivate providers to stay engaged in an HIE by facilitating pay-for-performance programs, increasing providers' reputation, or by providing information to better match patients' needs with community providers. However, communities that have providers less willing to have the quality of their care measured may view this capability as an obstacle instead of a motivator. [41]

This study provides evidence that HIEs may be successful if policies and programs foster trust, appeal to strategic interests, and provide benefits from quality measurement. Other business models which involve payments from patients directly for use of personal health records or from drug or medical device companies who use the data for marketing have been proposed but have not yet been fully tested. [74] If HIEs are to be sustainable, policymakers and HIE organizations should consider these factors when establishing HIEs. If HIEs do not account for these factors, HIEs may not provide sufficient value to healthcare providers and sustainability will continue to be a challenge.

2.8 Study limitations

While this study identifies some of the needs, motivations, and expectations of healthcare providers toward HIE, it would be premature to draw

strong conclusions about “what works and what doesn’t” because only one of the three Collaborative projects have become operational. Also, the information was collected for a specific decision point prior to implementation and does not capture changes in the stakeholders’ perspectives over time. Finally, the results may not be representative of other communities, especially because the costs of EHRs and the HIEs were borne by the Collaborative and because the communities were volunteers rather than a random sample.

2.9 Conclusions

The experiences of the three Collaborative pilot communities provide a revealing characterization of the perspectives of key HIE stakeholders. One overarching insight is that it appears unlikely that any of the communities would have moved to develop HIE very rapidly without assistance from the Collaborative. Important aspects of the stakeholders’ perspective include community-wide trust, strategic interests of the healthcare providers and of the community as a whole, and benefits derived from measuring quality of care. All communities ultimately selected a hybrid approach, which may be superior to the other two architectures; the selection process appeared helpful in engaging the communities. It remains to be seen if this effort or any HIE in the country can provide direct benefits from community-wide quality measurements or other activities. Without such benefits, HIE sustainability may remain precarious.

2.10 Epilogue

Of the three communities studied in this chapter, only the Northern Berkshire HIE became operational. The HIEs in Newburyport and Brockton never got up and running and have suspended their efforts, largely because of technical issues related to the different vendors failure to integrate their HIE and EHR products. Northern Berkshire had fewer technical integration issues presumably because they used the same vendor for the HIE and all community EHRs. The experiences of these communities underscore the technical difficulty of integrating these complex clinical systems.

The meaningful use payments may help to overcome these technical issues by requiring providers to use certified vendors as a condition of receiving payments. The payments may also influence the values of the participating providers discussed in this chapter to some extent, by changing their strategic interests and overcome trust issues so that they are more motivated to engage in HIE. However, the meaningful use criteria most relevant to HIE has not yet been specified and it remains to be seen if these incentives and new technical standards will be sufficient to foster HIE at a substantial scale.

Chapter 3 What affects clinicians' usage of HIE?

3.1 Abstract¹

Relatively little is known about what factors affect clinicians' usage of HIE. We performed a qualitative study using grounded theory and interviewed clinician-users and HIE staff of one operational HIE with advanced data exchange functionality. Seventeen 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. Clinicians were motivated to access the HIE by perceived improvements in care quality and time savings, but their motivation was moderated by a long list of factors including gaps in data, workflow issues and usability issues. Data contributions to the HIE were affected by billing concerns and time constraints. The study was limited in that only more intensive users of HIE were recruited and was restricted to one community and small number of specialties. Policies should create incentives for HIEs to assist clinicians' integration of HIE into their workflows, develop measures of HIE contributions and accesses, and create incentives for clinicians to contribute data to HIEs.

3.2 Introduction

Of more than one hundred HIEs in the United States, few are operational and even fewer have advanced data exchange capabilities such as providing access to a wide range of data that originate from many different medical practices as aggregate patient-centric records.[19] Most are focused on more basic functionality such as the delivery of laboratory results. Even if HIEs supported more advanced data exchange capabilities, clinicians may not find it valuable enough to use them if there are large data gaps or the interfaces are difficult to use.

¹ The contents of this chapter were published here: Rudin R, Volk L, Simon S, Bates D: What affects clinicians' usage of health information exchange? *Appl Clin Inf* 2011; 2: 250-262
<http://dx.doi.org/10.4338/ACI-2011-03-RA-0021>

The American Recovery and Reinvestment Act (ARRA) of 2009 commits approximately \$27 billion to stimulate the adoption of health information technology over the next several years. Most of the criteria for receiving payments related to HIE have not yet been determined but will be decided soon and official statements suggest that they will require advanced HIE functionality in the form of “access to comprehensive patient data.” [47] We did not find any studies, however, that have empirically assessed an operational HIE with this kind of advanced data exchange functionality. 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 a way that realizes 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 its advanced data exchange capability through an aggregate record for each patient and encompasses most physician practices in the community. We investigated the factors that affect both how physicians contribute data to the HIE and how they access it. 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.

3.3 Methods

3.3.1 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.[75] 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. These 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.

3.3.2 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.[76] 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.

3.3.3 Data collection and analysis

We used grounded theory to characterize the factors that influenced clinicians’ use of HIE functionality.[77] 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.[78] [41] [31] [56] The interviews were conducted in person (15) or over the phone (5) and most lasted one hour. We conducted the interviews, transcribed them from recordings, and analyzed the content of the transcripts 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 regular users of the HIE in the community.

3.4 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

(Figure 3.1). Moderators facilitate or inhibit clinicians' access of the HIE (Figure 3.2). 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.

3.4.1 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 factor for accessing the HIE.

3.4.2 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.

3.4.3 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.

3.4.4 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.

3.4.5 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.

3.4.6 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.

<p>Improve patient safety and quality</p> <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
<p>Save clinicians time</p> <ul style="list-style-type: none"> • Faster arrival at verified clinical data • Faster documentation
<p>Improve patient experience</p> <ul style="list-style-type: none"> • Less frustration for patients during interviews • Meets patients' expectations for efficient access to health information

Figure 3.1: Clinicians' Motivators for HIE Use

<p>Patients</p> <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
<p>Clinicians</p> <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
<p>HIE</p> <ul style="list-style-type: none"> • Completeness of HIE data • Technical usability of HIE • Technology dependability of HIE

Figure 3.2: Moderators of HIE Usage as Related to Patients, Clinicians and the HIE

3.5 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. [79] [66] 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. [31] 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)." [80] 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. [81] 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 physician's HIE usage as evidenced in audit logs.[79] 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. [56] [82] [83] [37] [84] [85] 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.[82] 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. [64] [68]

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. [86] 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.

3.6 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.[87] 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.[88] [89] 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 (Figure 3.3).

HIE usage Moderator: Stakeholder:	Completeness of HIE data	Integrating the 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 extension centers	Monitor: practice coverage, percent of patients consented, volume of timely data received	Monitor: HIE usage frequencies (motivate HIE training and promotion)	Monitor: HIE usage frequencies (motivate shorter downtimes, prudent technology selection)
HIE and HER product vendors	Certify: “preliminary” note locking functionality, capability to report volume and timeliness of received data	Certify: capability to report HIE accesses frequencies	Certify: various features (see text)

Figure 3.3: Policy Levers for Clinician Usage and Value of HIE

3.6.1 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.

3.6.2 HIE organizations

Currently, HIE organizations face enormous challenges, including defining their mission, satisfying various stakeholders, achieving sustainability and choosing technology vendors. [19] 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.” [67]

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.

3.6.3 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 independently 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. Such a feature may raise liability issues if clinicians share information that was meant to be only preliminary and other clinicians act on it. Clinicians will have to understand what software actions will make data available for other clinicians to view and how that data might be interpreted or misinterpreted. Further research is needed to better understand how this kind of communication might happen and who should be held liable in the event of a misinterpretation and harm done to a patient.

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.

3.6.4 Integrating HIEs with Direct Project

The federal government recently created the Direct Project to establish protocols for secure point-to-point communication among healthcare providers. [90] 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.[7] [9] [4] Also, there will be secondary uses of having an aggregate patient record such as quality measurement, disease registries and public health surveillance.[14] 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.

3.7 Study 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.

3.8 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. Meaningful-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.

Chapter 4 Care transitions as opportunities for HIE usage

4.1 Abstract²

The American Recovery and Reinvestment Act of 2009 will reward providers for “meaningful use” of electronic health records, including participation in clinical data exchange, but the best ways to do so remain uncertain. We analyzed patient visits in one community in which a high proportion of providers were using an electronic health record and participating in data exchange. Using claims data from one large private payer, we computed the number of care transitions between individual providers and medical groups as a percentage of total visits. On average, excluding radiology and pathology, approximately 51% of visits involved care transitions between individual providers in the community and 36-41% of visits involved transitions between medical groups. There was substantial variation in transition percentage across medical specialties, within specialties and across medical groups. Specialists tended to have higher transition percentages and smaller ranges within specialty than primary care physicians who ranged from 32 to 95 percent (including transitions involving radiology and pathology). Transition percentages of pediatric practices were similar to adult primary care, except that many transitions occurred among pediatric physicians within a single medical group. Patient visit patterns should be considered in designing incentives to foster providers’ meaningful use of health data exchange services.

4.2 Introduction

In chapter 3, we suggest that policies should promote the measure of HIE usage and pay providers or regional extension centers according to usage. To support assessment of HIE usage, this chapter suggests a simple method of computing the number of visits to a provider in which an aggregate patient

² The contents of this chapter were published here: Care transitions as opportunities for clinicians to use data exchange services: how often do they occur? Rudin RS, Salzberg CA, Szolovits P, Volk LA, Simon SR, Bates DW. *J Am Med Inform Assoc.* 2011 Apr 28

record would contain clinical data that the provider had not yet seen, based on whether a visit involved a care transition as opposed to a repeat visit to the same provider. We propose that some fraction of the number of visits which involve care transitions may serve as a reasonable target for the number of times a clinician might be expected to access an aggregate record HIE. This in turn could be considered in the meaningful use criteria, or related policies, aimed at fostering HIE. To better understand the nature of care transitions in which an aggregate patient record may be used, we explored patient visit patterns in one geographic community and compute descriptive statistics related to care transitions in that community.

4.3 Methods

4.3.1 Data sources

We analyzed claims data for members of a large private payer in a small community in New England, data which accounted for approximately 33% of all visits in the community. [91] The community had an established HIE with most of its medical groups participating. The data set included all claims, paid and unpaid, for years 2005 through the first half of 2009, which were submitted to the payer by providers who practiced within the six zip codes of the community, as well as claims from providers outside the community that were ascribed to any patient who had at least one claim from a community provider. Additionally, the data set included certain demographic information describing members and providers (but only providers within the community), current as of the end of the study period.

4.3.2 Community providers

Providers were represented by unique provider identification numbers, which were assigned to either individual clinicians or medical groups. We assembled a list of all provider numbers whose addresses were within the community's six zip codes and had at least one claim ascribed to them during the study period. We included all community providers regardless of whether or not they participated in the actual HIE. In most cases, the specialty and medical

group of the provider were supplied in the data. In addition, we used the name and address of the medical group given in the data and internet searches to determine or verify specialty and to assign to a medical group (e.g., one physician was labeled “emergency medicine” but also had an office practice for orthopedic surgery). We excluded anesthesiologists because they typically work only with other physicians and would not require a separate data exchange. We merged together any provider numbers that had the same identical names.

We excluded providers who had the fewest visits in the data set because the results related to those providers were unstable. We selected a cutoff of less than 300 visits during the four and a half year study period for excluding providers and tested the sensitivity of the findings with the threshold at 200 and 400 visits. Providers may have had low visit volumes for a number of reasons including, for example, that they worked part-time, they practiced in the community for only a short while, or they primarily cared for older patients which were not part of the data set.

4.3.3 Community patients

We included all patients enrolled in the health plan who had one or more claims for visits to a community provider in the data set. We excluded patients older than age 65 because many of those individuals may have also filed claims through Medicare, and we had no access to those data. For the included patients, we computed the age distribution and the gender ratio from members’ demographic information in the data set. To assess completeness of our data, for each patient, we calculated their active time span in the data set by counting the number of days between their earliest and latest claim and computed the number of active patients at any given time over the course of the study period.

4.3.4 Individual visits

From the claims data, we extrapolated provider visits. Multiple claims that contained the same date, provider and patient were considered part of the same visit. We excluded all claims labeled as facilities fees and other claims that were not labeled “professional.” We included only claims assigned to individual providers, though we did also test the sensitivity of our findings by including

claims assigned to medical groups. For inpatient claims, any claim submitted between admit and discharge date was considered part of the inpatient visit. Claims submitted on the same date as an emergency visit were considered part of the emergency visit.

4.3.5 Care transitions

For the primary analyses, we estimated care transitions to providers based on the visit patterns of each provider's patients. A visit was counted as a care transition if the patient's preceding medical visit in the community was to a different provider. We assumed that all community providers who were not specifically excluded contributed clinical data, immediately following every patient visit, to a hypothetical community-wide HIE and had access to the HIE's aggregate patient records. For each care transition, therefore, medical data would be available in the hypothetical HIE's aggregate record. Repeat visits to the same provider without intervening visits to other community providers were not counted as care transitions (Figure 4.1). This measure is similar to the "sequence" metric used by researchers to estimate continuity of care. [92] If more than one provider was visited by a patient on the same day, we ordered the sequences of those visits to minimize care transitions (e.g. if a patient visited providers A and B on the same day and then visited provider A again later that week, we considered the visit order BAA rather than ABA). We defined the *transition percentage* as the percentage of a provider's visits that involved care transitions.

We computed these and related metrics under the following scenarios:

- 1) Individual clinicians. We computed the clinicians' transition percentage, ignoring the clinicians' medical group membership. We computed average transition percentages by medical specialty to allow comparisons across specialties, and we also report variation within the specialties.
- 2) Medical groups. We computed transition percentages of medical groups. A visit was counted as a care transition only if the patient's preceding visit in the community was to a different medical group. We assumed providers remained in the same groups throughout the study period.

We did not assign inpatient and ED visits to individual providers because they tended to involve multiple clinicians and it was not clear which providers

would have been most likely to use the HIE for the visit. We combined inpatient and ED visits into one category because there was only one hospital in the community and the ED was attached to that hospital. For the group scenario, we included inpatient and ED visits as part of the hospital.

Patient visit pattern to providers A, B and C	Provider A: No. of care transitions/total visits (transition percentage)	Provider B: No. of care transitions/total visits (transition percentage)	Provider C: No. of care transitions/total visits (transition percentage)
Patient 1: AAAAAAAAAA	0/9	0/0	0/0
Patient 2: ABABABAB	4/4	5/5	0/0
Patient 3: AAAABBBBB	0/4	1/5	0/0
Patient 4: ABCAACABBA	3/4	2/3	2/2
Total for patients 1, 2, 3 and 4	7/21 (33%)	8/13 (62%)	2/2 (100%)

Figure 4.1: Example patient visit patterns with computed care transitions and transition percentages. Transition percentage is defined as the percentage of a provider’s total visits in which the patient’s previous visit was to a different provider. Each patient’s first visit in the study period with any provider would not count as part of their total visits for this provider because there was no way to determine if this first visit involved a care transition.

For both individual clinician and medical group scenarios, we computed the transition percentage for the community as a whole, and we tested the sensitivity of these estimates when including only those clinical specialties which we believed would be the primary users of an HIE (“core” specialties) and also when excluding radiology and pathology. All groups in this community included clinicians who were either core or non-core specialties, never both. We used only claims assigned to individual clinicians, but also tested the sensitivity of the results when including claims assigned to medical groups for the group scenario. We also computed the percentage of visits to all community providers for which the previous visit took place outside of the community.

We used SAS version 9.2, MATLAB version 7.8.0, and Excel 2003 to perform these analyses.

4.4 Results

We found notable variation in transition percentage across specialty, within specialty, and across medical groups even in this small community. Primary care physicians had a transition percentage of 54%, while in comparison, specialists tended to have higher percentages, averaging 79% for core specialties. Among primary care physicians, pediatricians had similar transition percentages compared to internists when considered as individual providers, but a pediatric medical group showed only 24%, reflecting a higher number of transitions internal to the group. Within specialties, primary care physicians showed the greatest range of transition percentage, varying from 32% to 95%. Medical groups had a wide range, and in particular the large group practice had about half the transition percentage of several smaller practices. For the community as a whole, excluding radiology and pathology, the transition percentage was 51% for individual clinicians and 41% for medical groups.

4.4.1 Provider characteristics

We identified 226 provider numbers in the community with at least one patient visit, 119 of which were assigned to unique individuals with more than 300 visits (Figure 4.2). Of those 119 providers, 80 were in core specialties (Figure 4.3). A wide range of specialties was represented in the community, including 34 providers that were considered to be primary care.

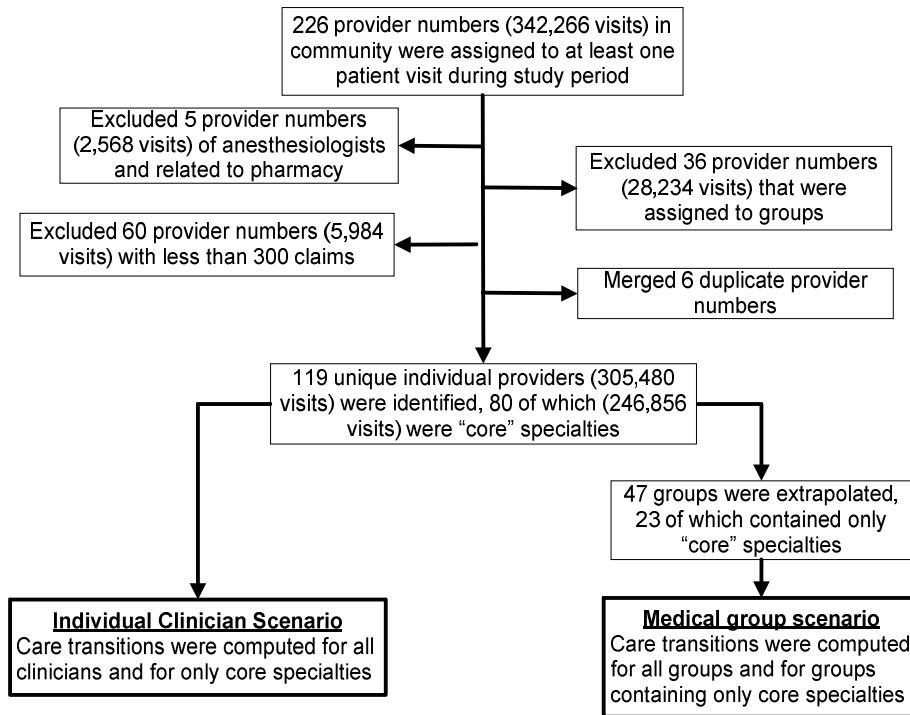


Figure 4.2: Community providers included in the study

Providers in Core Specialties (N = 80)	Providers in Non-core Specialties (N=39)
Primary Care (34) Family Practice (5) Internal Medicine (18) Nurse Practitioner (2) Pediatrics (9) Specialties (46) Cardiovascular Disease (2) Dermatology (3) Gastroenterology (1) General Surgery (2) Hematology/Oncology (1) Midwife (2) Neurology (2) Obstetrics and Gynecology (5) Ophthalmology (4) Oral & Maxillofacial Surgery (3) Orthopedic Surgery (4) Otolaryngology (1) Pathology (4) Podiatry (2) Psychiatry (2) Pulmonary Disease (1) Radiology (5) Urology (2)	Chiropractic(6) Clinical Psychology(7) Dentistry(8) Dietician Nutritionist(1) Mental Health Counselor(3) Optometry(3) Physical Therapy(6) Social Worker(5)

Figure 4.3: Specialties of community providers

4.4.2 Patient characteristics

The sample included 18,831 patients who were younger than 65 years and visited a community provider for more than one visit. Slightly more than half of the patients (55%) were female and the average age was 36. The average frequency of activity among patients was 826 days (median 832, IQR 269-1402) of a total possible 1641 days. The mean number of visits per patient during the study period was 19 (median 11, IQR 4-25).

4.4.3 Care transitions – individual community clinicians

We found notable variation in the transition percentage by clinical specialty (Table 4.1). Radiologists and pathologists had the greatest transition percentages, as may be expected, averaging greater than 95%. Providers with

low transition percentages included physical therapists and chiropractors with 22% and 25% of visits, respectively. Specialties with relatively high transition percentages included ophthalmology and obstetrics/gynecology with transitions occurring in 84% and 79% of visits on average, respectively. Primary care specialties fell in the middle range, with 54%.

We found that the transition percentage also varied to some extent within medical specialties. For example, internists and pediatricians showed notable variation. Transition percentages for both of these specialties ranged more than 45 percentage points with a standard deviation (weighted by number of visits) of greater than 10. Most specialties seemed more consistent, although there were fewer practitioners of these specialties in the community. Obstetrics and gynecology physicians ranged less than 20%, with 4 of 5 having transition percentages within the range 79-85%. The orthopedic surgeons had transitions of 71-74%.

Specialty	No. clinicians	No. visits	Weighted average transition percentage (weighted SD) [low-high]
Primary Care			
Family Practice	5	16,569	44.3 (7.3) [32.4-67.6]
Internal Medicine	18	66,411	54.6 (10.3) [35.0-95.2]
Nurse Practitioner	2	783	91.0 [88.1-93.3]
Pediatrics	9	41,008	56.2 (11.1) [45.1-93.2]
All primary care	34	124,771	54.0(11.3)[32.4-95.2]
Core Specialties			
Cardiovascular Disease	2	2,220	81.4 [60.9-85.3]
Dermatology	3	9,862	59.3[49.7-62.5]
Gastroenterology	1	4,517	68.4
General Surgery	2	2,551	78.1[77.4-82.9]
Hematology/Oncology	1	2,009	50.9
Midwife	2	783	91.1[88.1-93.3]
Neurology	2	4,430	61.7[58.1-80.4]
Obstetrics and Gynecology	5	13,972	79.3(6.9) [65.0-84.1]
Ophthalmology	4	6,166	83.9[79.2-87.3]
Oral & Maxillofacial	3	2,035	57.5[51.9-70.1]

Surgery			
Orthopedic surgery	4	10,051	71.6[70.8-73.7]
Otolaryngology	1	740	73.9
Pathology	4	5,938	98.7[98.7-99.0]
Podiatry	2	2,725	71.5[55.4-77.4]
Psychiatry	2	2,219	47.2[36.5-49.1]
Pulmonary Disease	1	665	87.4
Radiology	5	29,524	95.2(0.9) [94.2-97.6]
Urology	2	2,571	72.1[68.1-75.4]
Non-core Specialties			
Chiropractic	6	12,165	25.3(9.1)[12.1-47.0]
Clinical Psychology	7	3,573	32.2(14.3)[7.4-57.5]
Dentistry	8	12,861	59.3(5.1) [51.3-70.9]
Dietician Nutritionist	1	357	82.6
Mental Health Counselor	2*	2,039	23.9[9.3-23.7]
Optometry	2*	5,885	87.4[85.5-89.0]
Physical Therapy	6	16,570	22.1(2.7)[19.1-28.4]
Social Worker	5	2,282	31.9(4.6)[27.4-40.1]

Table 4.1: Transition percentages for individual clinicians, grouped by specialty.

Averages of each specialty are weighted by visit totals and so are equivalent to the portion of total visits to clinicians in each particular specialty that are care transitions. Standard deviations are also weighted by total visits and are computed as the square root of the weighted unbiased variance. We only report standard deviations for specialties for which the data contains five or more providers, and high/low for two or more. The number of visits excludes patients' first visits in the data set.

*One mental health counselor and one optometrist showed zero care transitions and, as such, were considered outliers and excluded.

4.4.4 Care transitions – medical group scenario

We also found notable variation in transition percentage among medical groups (Table 4.2). The hospital had the greatest transition percentage in the community, because of the radiologists and pathologists practicing there. Several group practices were single-specialty and had transition percentages similar to what the same type of specialists had in the individual scenario. The pediatric practice, however, showed a transition percentage of 24%, which was considerably less than any pediatrician's percentage in the individual scenario, indicating a large number of transitions within the group. The community's largest group also had a smaller transition percentage compared with most other practices.

Medical group description	No. of Clinicians	Specialties represented in group	Transition percentage (of total visits)
Group 1: Hospital	8*	Radiology (2), Pathology (4), Internal Medicine(1), Otolaryngology(1)	86.4% (of 18,403)+
Group 2: Large group practice	21	Multiple specialties++	36.8% (of 75,246)
Group 3: Medium-size group practice	6	Cardiology(2), Urology(2), Obstetrics/ Gynecology(2)	70.8% (of 10,343)
Group 4: Medium-size group practice	4	Orthopedic surgery	69.5% (of 9,993)
Group 5: Medium-size group practice	5	Internal medicine	41.2% (of 14,248)
Group 6: Medium-size group practice	5	Pediatrics	23.9% (of 20,890)
Group 7: Medium-size group practice	4	Ophthalmology	81.7% (of 6,164)
Group 8: Medium-size group practice	6	Family practice(3), Nurse Practitioner(1), Obstetrics/ Gynecology (2)	62.2% (of 14,039)
Group 9: Medium-size group practice	5	Physical Therapy	20.1% (of 14,542)
Group 10: Small group practice	1	Family Practice	43.1% (of 8,725)

Table 4.2: Care transitions between medical groups.

Only groups with greater than 6000 visits in data set are shown (except for one radiology group which is not shown). Care transitions between providers within the same group are not counted in the transition percentages.

* Clinicians who treat patients for inpatient and ED visits are not counted in the number of clinicians.

+ The hospital's transition percentage includes inpatient and ED visits. If these visits are excluded, the transition percentage is slightly higher, 88.5%. Most hospital visits are for radiology or pathology.

++ This group included: general surgery (2), internal medicine (11), nurse practitioner (1), neurology (1), obstetrics and gynecology (1), pediatrics (3), pulmonary disease (1), podiatry (1).

4.4.5 Community results

For the community in total, we found that the overall transition percentage ranged between 36% and 62% depending on various assumptions (Table 4.3). When providers are considered in their medical groups, their transition percentages are as much as 15% lower than when they are considered

as individuals, because of care transitions that occur internal to medical groups. Transition percentages among core specialties were similar to transition percentages among all provider types. When radiology and pathology visits were removed, the community transition percentage decreased by approximately 10%.

We performed several sensitivity tests on these results and found the results to be reasonably robust. Removing inpatient and ED visits from the group scenario resulted in negligible change in the community transition percentage, reflecting the fact that these types of visits represented a small portion of the total community visits. We changed the provider exclusion threshold to 200 visits and 400 visits, which involved adding 3,211 visits and excluding 4,448 visits respectively, for the individual provider scenario. We found negligible changes in transition percentages from these changes. We included 28,234 visits which were assigned to medical groups in the group scenario for all clinicians. The total community transition percentage rose from 50% to 52% as a result of the group claims with most groups having only one or two percentage changes and the largest change happening in the pediatric practice which showed a 4% increase in transition percentage from 24% to 28%.

Even though we did not have complete knowledge of the clinicians who worked outside of the community, we did estimate the total proportion of community visits which involved transitions from outside of the community, and assessed this proportion to be 14.5% of all visits to community providers. The data allowed us to calculate this because it included visits by patients to providers outside of the community. If a patient had visited a non-community provider before a visit to a community provider, we counted the visit to the community provider as a visit that involved a transition from outside of the community.

Scenario	Transition percentages (of patient visits)	Transition percentages (of patient visits), excluding radiology and pathology
Individual clinician: all providers	60.2% (of 283,613)	51.2% (of 247,105)
Individual clinician: core specialties only	62.2% (of 226,381)	51.5% (of 190,015)
Medical group: all providers	50.2 % (of 284,597)	40.6% (of 247,793)
Medical group: core specialties only	48.8% (of 226,346)	35.7% (of 189,929)

Table 4.3 Community care transitions per patient visit.

Inpatient and emergency visits were included in group scenarios and excluded from the individual scenarios. Differences in visits between individual and group scenarios are because we consider same day visits to the same group as part of the same visit in the group scenario.

4.5 Discussion

We found that transitions in care represented a substantial proportion of patient visits in one community. These visits represent opportunities for an aggregate patient record form of HIE to provide useful information. We also found a notable range of transition percentages across specialties, within specialties and across medical groups even among the modest number of clinicians in the data set.

We identified a few other studies that computed the frequency of care transitions for patients in a community, although most involved less broad clinical samples. For example, one study that investigated the frequency with which an HIE was accessed was restricted to emergency departments. [66] Another study evaluated the number of patients who visited more than one ED within a geographic region. [64] A study of the United Kingdom's effort to share clinical records was also restricted to emergency or unscheduled care settings.[93] Other studies that report HIE usage numbers did not focus on appropriate levels of usage based on patient visit patterns. [62]

4.6 Policy implications

If variation in transition percentage among clinicians is common in many communities, meaningful use payments and related policy incentives should consider patient visit patterns, in addition to visit volumes, in estimates of target HIE usage.

Many providers may not access an aggregate record HIE for every care transition for good reasons. Some patients' problems may be routine and data in the HIE may be unrelated to the patient's current problem or clinical episode. However, providers will often not be able to determine the relevance of the data without first reviewing them. We suggest that if providers – primary care especially – are to be responsible for coordination of patient care and comprehensive treatment of medical conditions, some fraction of the number of care transitions a provider encounters will represent a reasonable meaningful use target for a provider accessing an aggregate patient record HIE. What that fraction is should be addressed empirically. Which specific data types providers should be expected to view also represents an open question and likely varies by clinicians' specialty and the setting in which they are seeing the patient, as well as the specific circumstances of the patient's visit. In many clinical scenarios, providers may be expected to check for recent laboratory results, changes in problem lists and medications, or consultation notes.

Some providers may access an HIE even for repeat visits because information from the HIE had not been imported into the provider's EHR during the previous visit, or because the provider had no way of knowing whether or not new data was present in the HIE. HIE vendors may reduce the need for these accesses, which may be a burden on the provider, by providing functionality that allows automatic importing of HIE data into an EHR and by implementing a visual cue that indicates whether or not new data exists in the HIE as of the patients' previous visit.

In addition to assessing HIE accesses, meaningful use payments might also consider including accesses to medical groups' EHRs for care transitions that are internal to medical groups, which accounted for 10-15% of visits in the community we studied and may be more or less in other communities, although data exchange is much easier within a group that shares an EHR. This may be especially important for large medical groups in which many patients receive most of their care, because many care transitions will likely occur between

providers within those groups and incentives may be needed to ensure care within the group is coordinated. [94]

If measures of HIE accesses are to be used as part of incentive payments, HIE and EHR vendor companies must offer the capability to report these metrics. It is unlikely that vendors will develop functionalities to report metrics that can be compared across HIEs without some change in the incentives they face. We recommend that vendors should be required to support these metrics as a condition of certification. [95] Vendors would likely be able to compute counts of actual HIE accesses as well as the volume of care transitions from data they already capture in audit trails, although they should not be expected to develop their own algorithms for doing this—development of a single algorithm might be helpful and also could diminish the risk of “gaming.”

Gaming does represent a serious concern; in particular, direct incentives to providers simply for HIE accesses may not be a judicious approach to whether or not meaningful use is present. [96] The risk of gaming should be studied empirically. In addition to assessing providers’ usage, care transition metrics may be used to evaluate and compare the effectiveness of HIE organizations and regional extension centers in engaging clinical users. One option might be to incent HIEs in particular to have higher physician participation rates. We have observed in evaluating a working HIE that the doctors could have benefitted from some follow-up regarding how the HIE worked, more specifically simple training in the office might have showed them the benefits, but the HIE did not have an incentive to provide such training. [97]

4.7 Limitations

This study has several important limitations. The study focused on only one small community and may not generalize to other care settings. Visit patterns may be different in different kinds of communities, such as urban settings, and may have more or less variation in transition percentage. In addition, our claims data were limited to the claims submitted to one private payer, the results may not be generalizable to other payers. Also, visits from patients older than 65 years or from patients or providers not covered by the payer were not included. In addition, we may have included claims that did not occur in the community and excluded claims that did occur in the community

because of providers who practiced medicine in other regions under the same provider number. We also did not account for providers who changed medical groups during the study period. We may have missed a few care transitions that occur on the same day as an ED visits or inpatient admission or discharge. Finally, we assumed that the aggregate record in the hypothetical community-wide HIE had comprehensive, up-to-date data from all providers in the community under each scenario, which may be difficult to achieve for many HIEs in the near future.[97] Realistic usage targets will therefore likely be lower than the estimates in this study but will still be computable from the patient visit patterns of providers who participate in HIEs.

4.8 Conclusion

In this study within one community, we found that a substantial percentage of patient visits involved care transitions. This finding supports previous studies that identified significant potential use for HIE, especially for aggregate patient records. We also found notable variation in the proportion of visits that involved care transitions across providers and provider types in this community, which suggests that patient visit patterns should be considered in designing incentives to foster providers' meaningful use of health data exchange functionality.

Chapter 5 Impact of mergers of medical groups and variation in provider participation on the potential value of regional health information exchanges: a simulation of 10 communities

5.1 Abstract

Substantial resources are being invested in establishing health information exchanges (HIE). However, under pressure to form accountable care organizations, medical groups may merge, limiting the need to exchange data through external HIEs. Our simulations of 10 communities suggest that considerable consolidation of medical groups would have to occur to substantially reduce an HIE's value. However, our simulations also suggest that to be successful HIEs will have to recruit a large portion of the medical groups in a community. Hospitals and large groups will be key participants, but they alone may only cover 10-20% of total care transitions in communities.

5.2 Introduction

As discussed in prior chapters, health information exchange may be on the verge of a major expansion. More than one hundred organizations are operating or launching health information exchanges (HIEs) to enable the exchange of data between independent healthcare organizations. [19] Widespread HIE has the potential to create substantial clinical and financial benefits as a return on the current investment of hundreds of millions of federal and state dollars.[14] While initial HIE efforts have focused on the exchange of laboratory results, federal incentive programs are intended to spur many more HIEs to pursue more advanced forms of data exchange. These advanced capabilities include aggregate patient records – longitudinal medical records that are indexed by patients and consist of clinical data from multiple providers in a community. [19] [98] [99] [30] [62] [Rudin – ACI] Aggregate patient records represent a major federal priority. Although not yet completely specified, the federal incentive program for “meaningful use” of health information technology

is expected to give payments to eligible providers for “access to comprehensive patient records,” which may include use of aggregate patient records. [46] [47]

However, the potential value of community HIEs may diminish significantly if medical groups consolidate into larger organizations through mergers of medical groups or if hospitals and medical groups integrate into entities such as accountable care organizations. If two or more medical groups merge and adopt a shared electronic health record, data exchanges within the merged group could be executed internally, bypassing the HIE and reducing the HIEs’ potential value for many care transitions.[100] A wave of medical group mergers is already underway as hospitals and other entities are purchasing practices. Independent physicians may be moving toward employed status at a high rate. [94] [101] Accountable care organizations (ACO) may accelerate this trend, diminishing the number of opportunities for community medical groups to exchange data through an HIE.

Even if only few mergers occur, most HIEs will face another problem: recruiting and retaining medical groups. Like a telephone exchange, an HIE is only as good as its participating membership. Inadequate participation of community healthcare providers is one important threat to success for regional HIE organizations. [Rudin - ACI] Providers might decline to join an HIE for many reasons such as competition for patients, technical challenges, privacy and security concerns, legal issues, HIE-related fees, the lack of a business case, and they may not believe an HIE will have much of the information they need. [40] [41] [31] If few providers in a community contribute data to an HIE, the number of opportunities to use the HIE for improving patients’ coordination and continuity of care will be greatly reduced and the HIE’s potential value will be diminished.

The purpose of this chapter is to investigate how these two phenomena could affect the value of a community HIE as a provider of aggregate patient records: “mergers of medical groups” and “provider participation in the HIE.” To estimate the impact, we examined the proportion of relevant *care transitions* that would be served by an HIE under various simulated scenarios. A variety of policies and economic changes are currently influencing both the degree to which medical groups are merging and the likelihood of provider participation in community HIEs. [102] Because of this, we simulated how the potential for exchange of data would be altered under a selected set of illustrative scenarios

of medical group mergers and provider participation in community-wide HIEs using data from one commercial health plan including all professional claims for provider visits in ten communities.

5.3 Methods

5.3.1 Overview

To measure the potential value of an HIE, we defined a care transition as a sequential pair of patient encounters with different provider groups in a community. We assumed that a community-wide HIE could be used to transmit clinical data among these pairs of groups. We did not consider care transitions which involved sequential visits to providers in same group because data exchanges for those transitions could be done using the medical group's EHR and would not involve an HIE. To develop constructs of medical group mergers and provider participation and to investigate their impact on the potential value of community HIEs, we analyzed ten geographic communities which were either actively building an HIE or had applied within the past few years to receive a large grant for constructing a community-wide HIE. For each of these communities, we simulated various scenarios of medical group mergers and provider participation (described below).

5.3.2 Data sources

We used the same data set as in chapter 4: administrative claims data for members of a large private payer in 10 geographical communities in Massachusetts. We divided the data set into three 18-month periods to test for consistency of the results and for each study period we only included patients enrolled for the duration of the study period. The data set also included certain demographic information about the providers from the end of the last study period, which we used to assign providers to medical groups (Appendix 1.) We performed the entire analysis including all clinical specialties and also performed a separate analysis for only "core" provider specialties, those in which the providers were likely to be frequent HIE users. This core group included most physician specialties and nurses. We excluded radiologists and pathologists from

the core specialties because those providers tend to have high volumes of care transitions which would dominate the simulation results and interfere with closer examination of data exchanges among the other specialties. (See appendix 1 for a complete list of specialties considered core and non-core.)

5.3.3 Measuring care transitions

We used the same method described in chapter 4 to identify provider visits and clean the data. Appendix 1 contains the methodological details that differ from chapter 4. Notably, in this chapter, we did not group providers based on their group name, only their address and a few other factors as explained in appendix 1. Also as with chapter 4, a care transition was identified based on the sequence of provider visits and was counted if the patient’s preceding medical visit was to a different medical group (Figure 5.1).

To estimate potential value of the HIE, we computed the total number of patients’ care transitions between the medical groups which were assumed to be participating in the community HIE under each simulated scenario. For each of the ten communities, we computed the baseline number of care transitions by assuming that all included medical groups participated in their community HIE and none of them had merged. The specific simulation patterns generated for both medical group mergers and for provider participation are described below.

One patient’s visit sequence to medical groups A, B and C	Baseline no. of care transitions	No. care transitions covered by HIE if groups A and B merged	No. care transitions covered by HIE if group C was not participating
AAAAAAAAAA	0	0	0
ABABABABAB	9	0	9
AAAAABBBBB	1	0	1
ABCAACABBA	7	4	4

Figure 5.1 Example patient visit sequences

Example patient visit sequences and corresponding number of care transitions covered by an HIE.

Care transitions are opportunities for participating providers to access new data in the aggregate patient records of a community HIE.

5.3.4 Simulations

We performed two simulations which generated scenarios of medical group mergers and two more simulations which generated scenarios that varied provider participation.

(S1) Large mergers. This simulation shows the cumulative impact of mergers of medical groups. After computing the baseline number of care transitions that occurred in one study period assuming full participation by community medical groups, this simulation then computes the number of care transitions that would be covered by the HIE if the two groups that share the most care transitions between them had merged. A merger of these two groups would reduce the number of care transitions covered by the HIE more than any other merger. The simulation then repeats until all of the groups have merged into one community-wide group with zero care transitions. By selecting the mergers involved in the most care transitions, this simulation examines the cumulative effect of larger mergers on the value of an HIE.

(S2) Small mergers. This simulation is the same as S1 except that the merged groups are selected by taking the group with the smallest number of visits in the data set and merging it with the group with which it shares the largest number of their care transitions. Like S1, the simulation repeats until all groups merge into one community-wide group. It can be understood as the converse of S1 in that it examines the cumulative effect of smaller mergers on the value of an HIE.

(S3) Recruitment. This simulation shows how the value of an HIE grows with increasing participation of medical groups. Starting with only one group participating, the initial value of an HIE in this simulation is always zero. With each additional group, the number of care transitions covered by the HIE increases. This simulation begins with the medical group that is involved in the most care transitions in the community and iteratively adds the group involved in the next most volume of care transitions until it reaches the baseline case of all groups participating. It therefore reflects one extreme case of how HIEs may recruit medical groups.

(S4) Retention. This simulation is the opposite of S3. It begins with the baseline case of full community participation and then simulates the non-participation of only the group that is involved in the most care transitions in the community. Using the same sequence of groups as S3, it then iteratively simulates the non-participation of the group involved in the next most volume of care transitions until none of the groups are remaining. This simulation illustrates how important it would be to retain the groups that have the most potential value to an HIE. It is analogous to a targeted attack on a network in which the

nodes that would reduce the network's value by the greatest degree are attacked and removed from the network. [103]

For each simulation, we only varied either the group structure (for S1 and S2) or which groups participated in the HIE (S3 and S4). The time period was kept constant for every scenario within each simulation. Holding the simulation time periods constant allows an examination of the effect of our two phenomena on HIE value, but does not represent realistic merging and recruitment events which would occur over time.

We performed the four simulations on the claims data for each of the ten communities, separately for core providers and for all providers, and for each of the three study periods. We executed the simulations using MATLAB version 7.9.0 (R2009b) on the high performance computing cluster at Partners Health Care in Boston.

5.3.5 Analysis

For each community, we computed the number of study patients, total visits, visits per patient, and number of medical groups. We also computed the transition percentage – defined as the portion of visits for which the previous visit in the community was to a different medical group.[100] To calculate market concentration, we used the Herfindahl-Hirschman Index (HHI) which ranges from near 0 (many small firms) to 1 (only one large firm). The HHI is computed by squaring the market share of each group in the community and then summing the resulting numbers. To represent the market share of each group, we used the number of patient visits to that group during the study period.

For each simulation, we computed specific metrics that summarize the results. For all community characteristics and simulation metrics, we computed the median and range across the communities, how they differed across the three study periods, and between core specialties compared with all specialties. We normalized the results based on the number of medical groups in each community, which we calculated as the number of groups that would account for

99% of community care transitions. This excluded the smallest groups because they would not have much of an impact on the value of the HIE.

5.4 Results

5.4.1 Community characteristics

The communities showed a wide range along several dimensions (Table 1). There was a five-fold variation in the number of study patients per community, and an eight-fold variation in the number of medical groups per community. The number of visits per patient to core providers ranged between 3.6 and 6.1. The transition percentage – defined as the portion of visits for which the previous visit in the community was to a different medical group – also varied substantially across the study communities, 29.8-50.1% for core providers. We found that the market concentration of visits differed by a factor of more than 6 on the Herfindahl-Hirschhorn Index (HHI) among the communities for core specialties, and the community with the fewest patients (community number 10 table 5.2) was also the most concentrated by a substantial degree.

Community ²	No. patients	No. visits ³	Visits/patient	No. transitions	Transition percentage ⁴	HHI	No. groups
1	51,434	295,460	5.74	138,114	46.75%	0.0225	182
2	19,436	88,470	4.55	29,817	33.70%	0.0329	72
3	46,911	191,828	4.09	70,662	36.84%	0.0372	107
4	20,538	126,028	6.14	63,139	50.10%	0.0394	62
5	49,040	217,304	4.43	76,680	35.29%	0.0401	101
6	56,799	225,887	3.98	81,857	36.24%	0.0405	105
7	40,001	144,048	3.60	45,273	31.43%	0.0409	76
8	17,896	70,856	3.96	30,783	43.44%	0.0453	38
9	16,740	75,678	4.52	22,532	29.77%	0.0715	34
10	9,856	54,395	5.52	23,596	43.38%	0.1421	22
median[min- max]	30,269.5[9,856- 56,799]	135,038.[54,395- 295,460]	4.48[3.60- 6.14]	54,206.[22,532- 138,114]	36.54%[29.77%- 50.10%]	0.0403[0.0225- 0.1421]	74[22- 182]

Table 5.1 Community characteristics (core specialties only).¹

1. Includes visits to core specialties from patients who were fully enrolled with one private payer from January 1st 2005 until June 30th 2006.
2. Communities are presented here in order of increasing Herfindahl-Hirschman index (HHI)
3. Excludes each patient's initial visit in the study period because there is no way to determine if that visit involved a care transition.
4. Transition percentage is defined as the percent of total visits to community providers for which the patient's previous visit was to a different medical group in the community.

5.4.2 Simulation results

The ten communities we studied showed modest variation in potential value under the simulation scenarios we used (Table 5.2). We present the results for core specialties in period 1. (See appendix 2 for sensitivity analysis with all specialties and across three study periods.)

In all communities, S1 results show that the potential value of HIE could withstand considerable merging: the number of groups could reduce by 20-36% through the most high-impact mergers (via 6-41 mergers) before potential value was reduced below 50%, for core specialties (Table 5.2). Under the pattern of consolidation simulated in S2 in which smaller groups merged into larger ones, as long as there were between 4 and 9 groups remaining (3-13% of the number of original groups), an HIE would still have 50% of its potential value (Figure 5.3).

The simulation of provider recruitment in S3 showed that a substantial number of groups would need to be recruited for an HIE to have a substantial value: a median of 18.5 groups (range 6-35) which consisted of 18-36% of total community medical groups would need to participate to achieve 50% of the HIE's potential value. Conversely, S4 shows that if the HIE cannot retain only a relatively small number of key groups, 2-10 groups which consist of 5-13% of the total community medical groups, the value of the HIE would be limited to 50% of its potential.

If these 2-10 key groups were the only groups recruited, S3 shows that they would only realize 10-20% of the HIEs' potential value (Table 5.3). The communities would have to recruit approximately 2 and 4 times the number of these key groups to achieve 50% of their potential value (Table 5.2).

Community1	No. groups2	S1		S2		S3		S4		No. group absences which would reduce potential HIE usage by > 50%5,6
		No. big mergers which would reduce potential HIE usage by > 25%3	No. big mergers which would reduce potential HIE usage by > 50%3	No. consolidated groups needed for potential HIE to be > 30%4	No. consolidated groups needed for potential HIE to be > 50%4	No. groups needed to participate to achieve 15% potential HIE usage5,6	No. groups needed to participate to achieve 50% potential HIE usage5,6	Reduction in potential HIE usage from absence of 2 groups5,6	Reduction in potential HIE usage from absence of 5 groups5,6	
1	182	18	41	4	7	8	35	17.66%	34.27%	10
2	72	12	24	4	9	7	23	28.01%	46.51%	7
3	107	12	25	4	7	7	23	23.37%	41.32%	8
4	62	8	17	2	4	5	15	29.43%	52.51%	5
5	101	10	23	4	7	6	22	25.41%	43.09%	7
6	105	10	22	3	5	6	20	25.12%	46.60%	6
7	76	9	18	6	8	6	17	27.92%	50.81%	5
8	38	8	14	4	7	6	13	30.12%	51.70%	5
9	34	7	13	3	6	5	13	37.12%	62.36%	3
10	22	2	6	2	4	2	6	63.52%	82.35%	2
median[min- max]	74[22-182]	9.5[2-18]	20.[6-41]	4.[2-6]	7.[4-9]	6.[2-8]	18.5[6-35]	27.97%[17.66%- 63.52%]	48.70%[34.27%- 82.35%]	5.5[2- 10]

Table 5.2 Summary results (core specialties only from January 1st 2005 until June 30th 2006)

1. Communities are presented here in order of increasing Herfindahl-Hirschman index (HHI)
2. No. groups are those that constitute 99% of community care transitions.
3. The sequence of mergers was decreasing by number care transitions between the pairs of medical groups in each geographic community.
4. Consolidation was simulated by iteratively merging groups that had the smallest visit volumes into the groups with which they shared the most care transitions.
5. The sequence of the groups is decreasing by volume of care transitions in each geographic community.
6. The denominator for these percentages is the potential HIE usage for the study period in each community assuming complete participation and no mergers i.e. the total number of care transitions between groups during the study period.

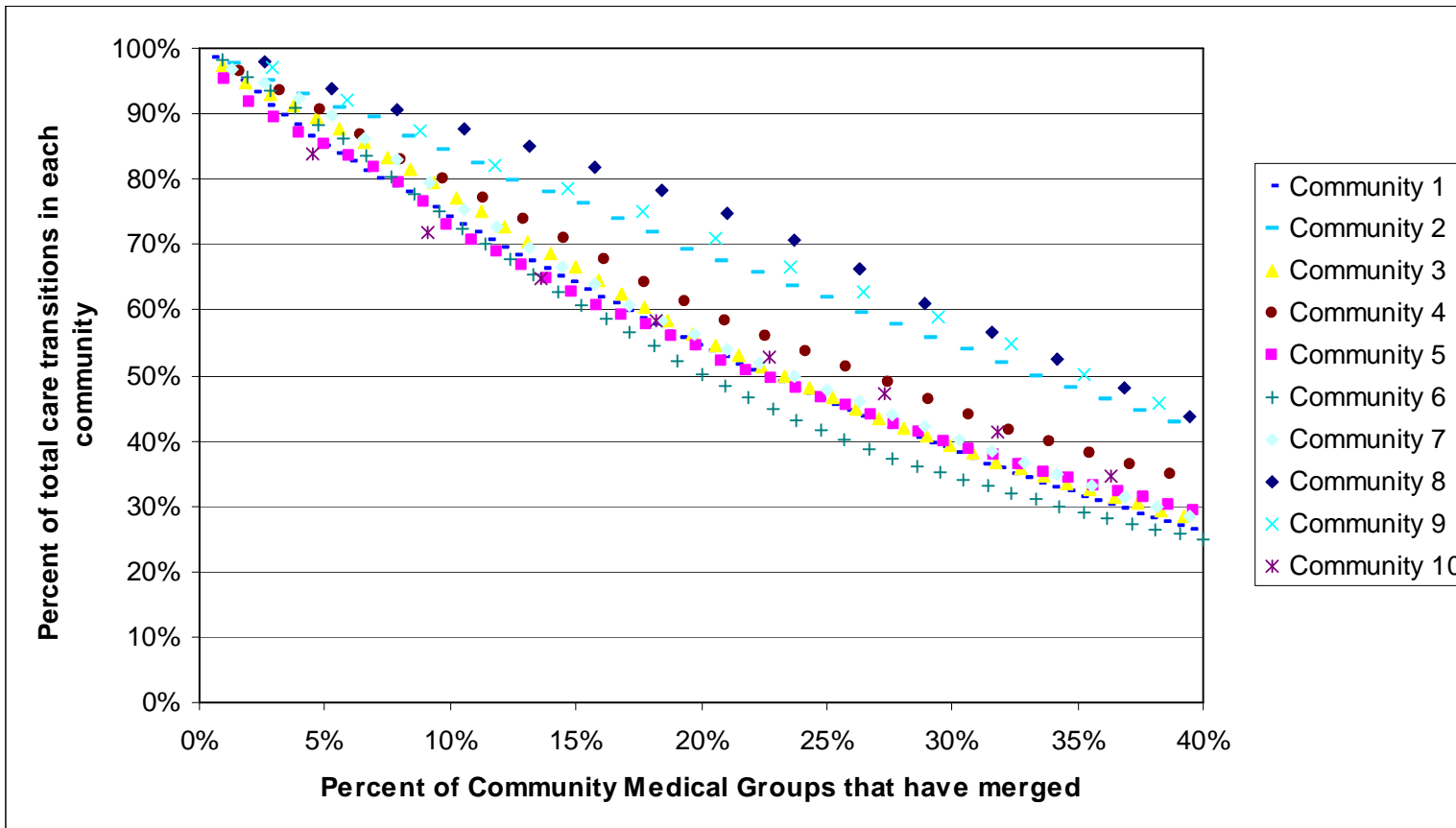


Figure 5.2 Larger mergers (S1)

This pattern simulates the effect of mergers of medical groups on the potential value of community HIEs. Groups are chosen to merge based on the pairs of groups with the most care transitions between them and so the first merger has the largest effect. The data include only core specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

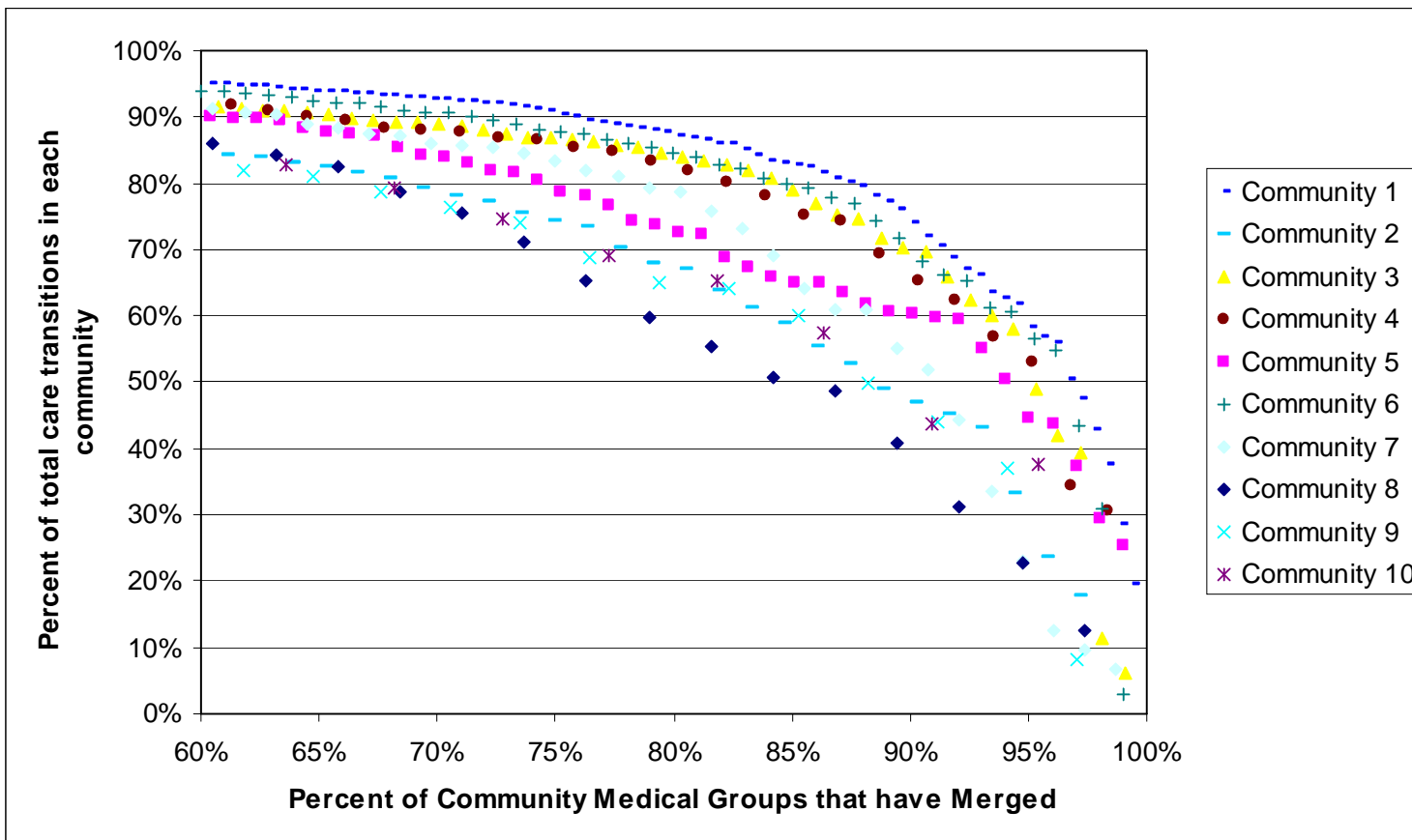


Figure 5.3 Small mergers (S2)

This pattern simulates the effect of mergers of medical groups on the potential value of community HIEs. Groups with the smallest visit volumes are chosen to merge with the group with whom they share the most care transitions and so the first mergers tend to have small effects. The data include only core specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

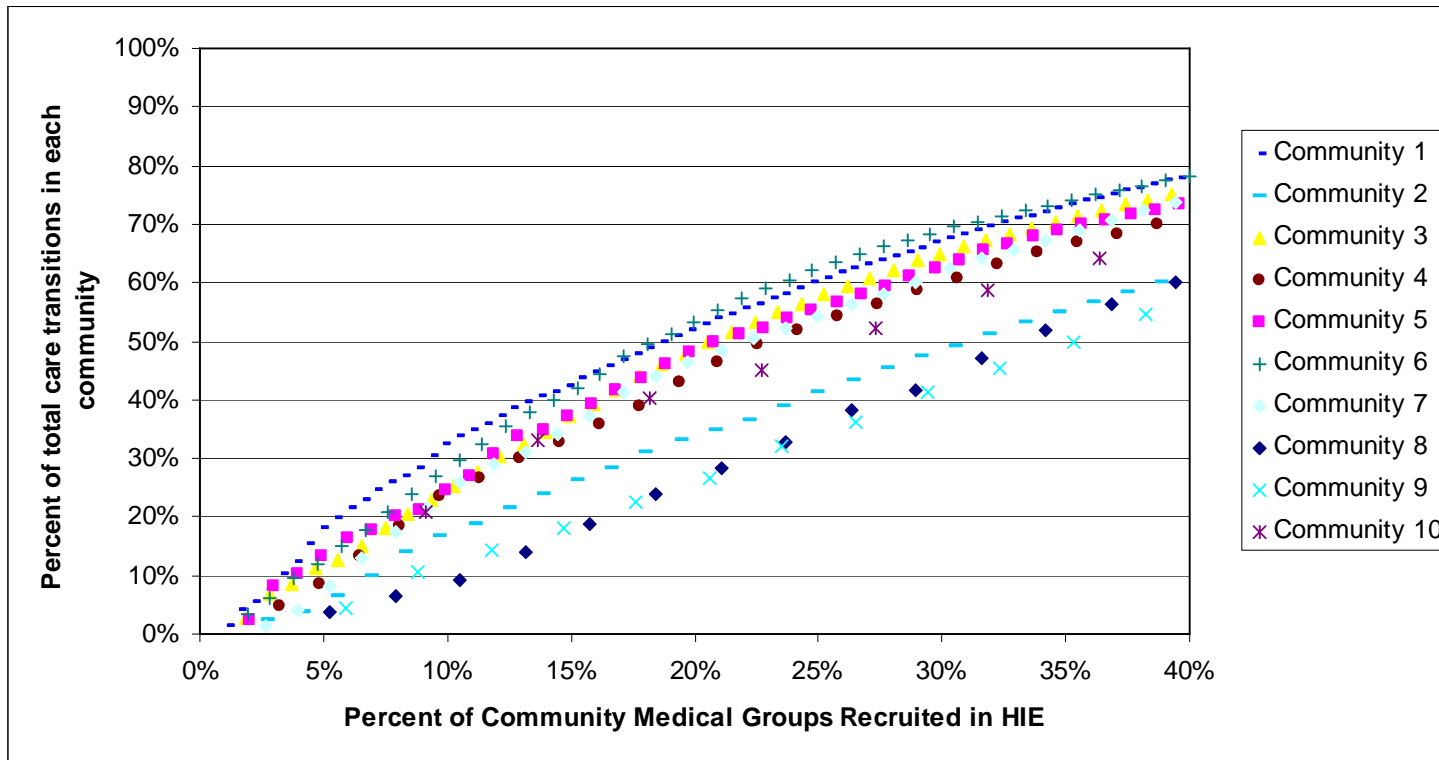


Figure 5.4 Recruitment (S3)

This pattern simulates the effect of medical group participation in community HIEs on the potential value of the HIEs beginning with one group participating. The sequence of groups is determined by decreasing volume of care transitions in each community. The data include only core specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

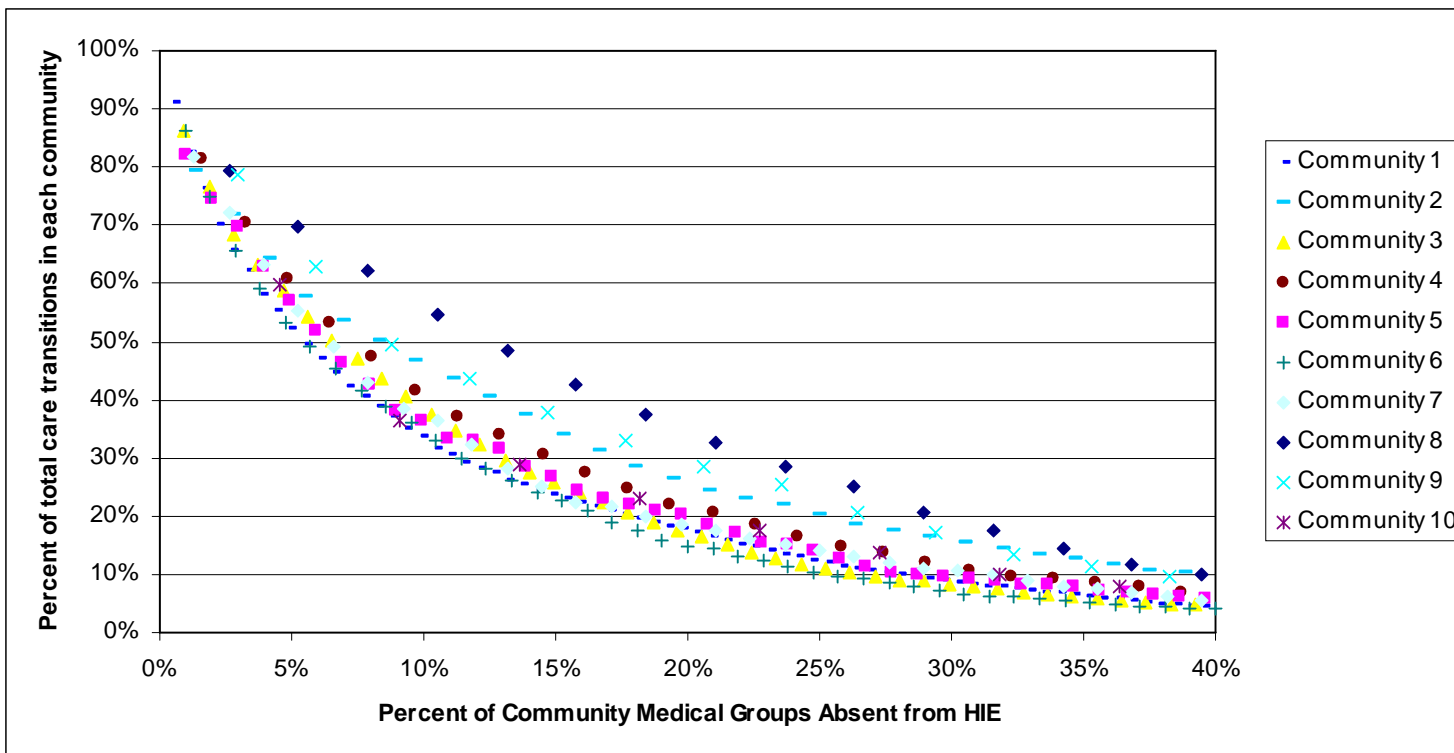


Figure 5.5 Retention (S4)

This pattern simulates the effect of the absence of medical groups from community HIEs on the potential value of the HIEs beginning with full participation. The sequence of groups is determined by decreasing volume of care transitions in each community and so the first group has the largest effect. The data include only core specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

Community	No. key groups ¹	Percent of total groups that are key groups ²	Key group descriptions ³	HIE value with key groups only (S3)	Decrease in potential value of HIE if key groups do not participate (S4) ⁴
1	10	5.49%	Hospital, Multispecialty, Multispecialty, Dermatology, Orthopedic Surgery, Multispecialty, Multispecialty, Primary care & Pediatrics, Hospital, Otolaryngology	19.71%	50.42%
2	7	9.72%	Hospital, Primary care, Multispecialty, Primary care, Cardiovascular Disease, Primary care, Pediatrics	16.63%	53.35%
3	8	7.48%	Hospital, Multispecialty, Multispecialty, Orthopedic surgery, Obstetrics & Gynecology, Pediatrics, Primary care, Orthopedic Surgery	20.16%	53.02%
4	5	8.06%	Hospital, Primary care, Primary care, Ophthalmology, Obstetrics & Gynecology	18.54%	52.51%
5	7	6.93%	Multispecialty, Hospital, Primary care, Hospital, Multispecialty, Primary care, Primary care	17.75%	53.61%
6	6	5.71%	Multispecialty, Hospital, Multispecialty, Multispecialty, Primary care, Orthopedic Surgery	15.11%	51.00%
7	5	6.58%	Hospital, Dermatology, Multispecialty, Orthopedic Surgery, Multispecialty	13.11%	50.81%
8	5	13.16%	Hospital, Primary care & Pediatrics, Primary care, Primary care, Orthopedic Surgery	13.85%	51.70%
9	3	8.82%	Multispecialty, Hospital, Multispecialty	10.67%	50.36%
10	2	9.09%	Multispecialty, Hospital	20.85%	63.52%
median[min- max]	5.5[2-10]	7.77%[5.49%-13.16%]	N/A	17.19%[10.67%- 20.85%]	52.11%[50.36%- 63.52%]

Table 5.3 Key medical groups (core specialties only).

1. Key groups are those involved in the most care transitions in the community and would limit HIE value to <50% of potential if they did not participate.
2. Total groups are those that constitute 99% of community care transitions.
3. The group descriptions are ordered from those involved in the most community care transitions to the least.
4. Assumes all non-key groups participate in HIE

5.5 Discussion

We simulated the impact of medical group mergers and provider participation in the HIEs on the potential value of HIEs in ten geographical communities. Our results suggest that, for at least certain patient populations younger than age 65, a limited number of mergers may not threaten the value proposition of community HIEs, except for communities which are highly concentrated. Furthermore, considerable consolidation of smaller providers may occur before an HIE's value proposition is substantially diminished. However, our results also suggest that participation by hospitals and other key medical groups, while important, may not be sufficient for HIEs to achieve their potential value in regional communities. These key providers may be involved in more care transitions with other medical groups in the community than with one another.

Few other studies examine the potential value of HIE by investigating patient visit patterns and those that do to date have mainly been limited to emergency or acute care facilities.[68] [64] [79] Other studies have investigated care fragmentation by counting the number of different providers that patients visit in a given year and how providers are linked to other providers via shared patients. [2] [104] [3] However, these studies do not consider care transitions, which is important for estimating potential HIE usage.

Even though all ten communities were located in one state, the communities' characteristics differed notably, suggesting they may be represent at least some of the diversity that may be found in other parts of the U.S. For example, the number of visits per patient ranged from 3.6 to 6.1. This may reflect differences in patient visit patterns and crossover with providers in neighboring communities. Also, the transition percentage ranged 28.9-50.1% across the communities. This notably range might reflect differences in group structure, provider specialties, patient visit patterns, or differences in other patient or provider characteristics among the communities. The HHI of market concentration also showed a wide range.

The findings in this study may be relevant to some of the key issues facing HIEs today, including working with accountable care organizations, recruiting a critical mass of providers, and paying for HIE services.

5.5.1 Accountable care organizations

Accountable care organizations (ACO) may be important clients for many HIEs. [102] [105] [106] How ACOs and HIEs will be structured is unknown: some communities may have one community-wide ACO whose members all participate in the same community-wide HIE; other communities will likely have multiple ACOs which share the same HIE; [84] and others may involve more complex arrangements in which individual medical groups participate in multiple ACOs or multiple HIEs. Regardless, ACOs and HIEs will need to work together to achieve their goals of improving care quality and reducing cost.

ACOs and HIEs with high rates of “leakage” or “crossover” of patient visits with neighboring communities may have difficulty determining which collection of medical groups would optimize their ability to measure quality or to maximize HIE value. Simulations or research into “community detection algorithms” may yield insight for this problem. [107] Because regulations will not restrict Medicare patients from seeking care outside of an ACO, patient crossover may not be reduced in the near future. [105] However, there may be significant advantages for patients if they stay within the same HIE or ACO, such as improved coordination of care, more effective use of automated decision support tools, better measurements of provider quality, and more familiarity with their providers. HIEs, ACOs, and policymakers may want to begin considering how to motivate patients to stay within their participating medical groups, perhaps through tiered copayments. [108]

However, there will likely always be a need for ACOs or HIEs to share data with external providers. Yet, communities in which one ACO and one HIE dominate may attempt to “lock in” patients by electing to restrict electronic exchange of clinical information to only those providers within their organization, even if many patients receive care externally. This may be especially true for early stage ACOs which are still paid primarily using a fee-for-service model and because they will still profit from having more patient encounters. Policies must ensure that ACOs share data with other ACOs as appropriate. This may be less of a concern for later stage ACOs that are paid more based on quality measures and, therefore, have an incentive to share data if it would improve care quality.

ACOs may increase the likelihood that medical groups will merge, and adopt the same EHRs, because of a decrease in antitrust restrictions and because larger groups may be more efficient in delivering higher quality care.

[109] While our study shows that an HIE may still be important even if there are many mergers, ACOs may create incentives for enough mergers in some communities to put into question the value of an HIE. On the other hand, some providers may want to have control of their patients' data should they decided to leave an ACO, and a merger in which providers adopt the same EHR would not allow that kind of flexibility.[84] It is therefore unknown at this point if medical groups will merge and adopt shared EHRs on a scale that would pose a substantial threat to the value proposition of HIEs.

5.5.2 Critical mass of providers

Many HIEs begin with only a few large hospitals and large provider groups. [30] [31] [79] [81] Small practices have been slow to participate. [37] Our results suggest that hospitals and other key medical groups are important to HIEs, but despite this they may not constitute a critical mass for many communities. Therefore, HIEs will need to recruit many smaller providers to realize most of their potential value. [97]

More concentrated communities generally had fewer key medical groups. Potential HIE usage for the most concentrated community was greatly affected by the participation of only two groups: the hospital and one branch of a large multispecialty group. In communities in which patient visits are concentrated in relatively few medical groups, a few mergers could reduce potential value substantially; whereas in the more diffuse communities, a much larger number of mergers would need to happen to have the same proportional effect. However, there may be exceptions to these tendencies if, say, communities with relatively diffuse market concentrations had high volumes of care transitions among a smaller number of groups.

To encourage participation, incentives and workflow interventions may need to be customized to different kinds of providers. Hospitals and larger groups may be more worried about sharing data with competitors, and may therefore be a particularly good target for either strong incentives and/or close monitoring that data are actually being contributed. [40] [41] The barriers for smaller groups, by contrast, may relate to different factors such as lack of technical expertise and these groups may need considerable technical support. [110] Many medical groups will likely require training in how to integrate the HIE

into their workflows. [35] The meaningful use payments may help accelerate HIE adoption for many medical groups, but they may be more effective for some types of groups than others. Further research is needed to understand where the meaningful use program works and where it doesn't. Additional policies and incentives may be necessary.

5.5.3 Who should pay for HIE?

If health information exchange can be shown empirically to reduced costs or improve quality, payers may have an interest in creating incentives that encourage the medical groups with whom they contract to participate in HIEs. [14] An analysis of the effect of each groups' participation on potential HIE value, similar to what we do in the recruitment and retention simulations (S3 and S4), could help inform the payment rates with empirical justification and provide a better estimate of value compared with a flat fee per physician. [56] To avoid free-riding among payers, all the major payers in a community may need to coordinate to perform this kind of analysis, perhaps via a third party, so that their HIE payment rates are fairly distributed among the payers. This kind of differential fee schedule may be especially important for communities which contain large medical groups that provide comprehensive care for many patients (e.g. Kaiser Permanente) because they may employ many physicians but have relatively little need for HIE because of their patients' visit patterns. Further research might be needed to understand the nature of the value chain in HIE to inform the specific payment rates.

As HIE technology improves, providers may be more willing to pay for HIEs themselves, especially if they find HIEs save them time and helps them deliver better care, which may improve their chances of receiving quality payments. Providers may then have an interest in adopting a differential fee schedule for HIE instead of payers. Estimates of potential value based on patient visit patterns may be more effective as the basis of payment compared with requiring providers to pay for each HIE access because that would involve a disincentive for accessing the HIE.

5.5.4 Limitations

This study was limited to patients younger than 65 years who were continuously enrolled with one private payer, and to providers with office addresses within ten communities in Massachusetts. None of the communities included a major urban center. The payer's market penetration may have varied across the communities which may limit the comparability of the communities. We did not verify the provider assignments to their medical groups, and we assumed all providers stayed in the same groups for all three study periods. The method we used to assign providers to groups may have overestimated medical group fragmentation by separating those clinicians who share an EHR but reside in different suites or addresses, or underestimated fragmentation by combining those clinicians who reside in the same suite or address but use separate EHRs. (Many clinicians may not even have EHRs yet.) We likely overestimated the number of medical groups in each community because many providers had few visits. Adjusting the results by reducing the number of medical groups would strengthen our major conclusions. (See appendix 2.)

Potential value as estimated by care transitions may be very different from actual value because providers may not use an HIE for every care transition. However, we could not find enough data in the literature on actual usage to use in our simulations. We did not stratify types of care transitions by value because we could not find any studies that created such a stratification. However, some types of data exchange are clearly more important than others. Our study is also limited to the aggregate patient record form of HIE which involved a centralized repository (called the hybrid model in chapter 2); we did not model other forms of HIE, such as point-to-point data exchange between medical groups. [90]

The patterns we used for the simulation were contrived; we could not find any evidence of the likelihood that certain types of medical groups would or would not participate in HIEs or of their likelihood of merging. The patterns we used considered variation in participation and merging separately; however, many community HIEs may experience variation in both of these factors. We also did not consider the affect of medical groups separating into smaller groups or the establishment of new groups.

Finally, for all simulations, we used the total care transitions which occurred in the community as the denominator for estimated potential value.

However, HIEs may also be interested in maximizing the percentage of care transitions covered by the HIE for only participating providers or using other metrics to evaluate their success.

5.6 Conclusions

In this early study of the care transitions and potential value of community HIEs, we analyzed visit patterns of patients enrolled with one private payer. Our findings suggest that, for many communities, mergers between medical groups will not threaten HIE's value proposition unless many of them occur. Therefore it would be prudent to continue to invest in HIEs. However, our results also suggest that while most communities contain a few key medical groups that would be critical participants in an HIE, they would likely not be sufficient to realize most of the potential value in the community. Additional incentives – carrots or sticks – maybe necessary to ensure that enough groups participate in HIEs for them to realize their potential value.

This study demonstrates that an analysis of patient visit patterns can provide important insights into the potential value of HIEs. Individual HIEs may benefit from performing similar analyses as they grapple with issues related to working with accountable care organizations, provider recruitment, and financial sustainability.

5.7 Appendix 1 – Methodology details

Designating medical groups

We designated provider numbers in the data set who were listed at the same address as part of the same group. For provider numbers listed at the same address, in a large office building for example, we used the follow steps to designate groups:

1. Put provider numbers which share the same suite number into the same group. (Some providers do not have a suite number.)

2. Of the groups formed in step 1, merge together any groups that have provider numbers with the same listed practice name. (Some providers do not have a listed practice name.)
3. For the remaining provider numbers without listed suite numbers but who do have listed practice names:
 - a. Merge the provider number into an already formed group that has the same listed practice name.
 - b. Put the remaining provider numbers into groups who share the same listed practice name.
4. For the remaining provider numbers without any listed suite or practice name:
 - a. Merge the provider number with the already formed group that has the most provider numbers of their same specialty. (Often there is only one option.)
 - b. Merge the remaining provider numbers with the already formed group that has the most provider numbers in the same specialty category, as defined below.
 - c. Form new groups of the remaining provider numbers by grouping specialties according to their same specialty categories.
 - d. For hospital addresses, assign radiologists, pathologists and anesthesiologists to the hospital even if they had another group listed

Specialty categories:

1. Ophthalmology, Optometry
2. Clinical Nurse Specialist, LICSW, Psychiatry, Psychology (Note: Clinical Nurse Specialist is also included in category 6)
3. Dentistry, Endodontics, Periodontics, Oral surgery
4. Anesthesiology, Chiropractic, Neurology, Occupational Therapy, Orthopedics, Physical Therapy Physical Medicine & Rehabilitation, Podiatry
5. Audiology, Otolaryngologist
6. All other core specialties and Dietary Nutritionist
7. All other non-core specialties

Assigning visits to medical groups

All included claims that were listed as occurring in an office-based facility were assigned to the group to which the provider number was assigned as per the method above. Multiple claims ascribed to the same patient and provider number for the same date were considered part of the same visit.

Claims that were listed as occurring in an inpatient facility as well as all emergency claims (as indicated by CPT codes) were considered as part of the same hospital visit if they contained overlapping visit dates. These hospital visits were assigned to a community hospital in our analysis if one or more claim involved with the visit was ascribed to a provider number associated with that hospital. If an inpatient visit did not involved any claim associated with a community hospital, the visit was excluded because the visit may have occurred at a hospital outside of the community. If an inpatient visit involved claims associated with more than one community hospital, the visit was excluded because we were unable to determine at which hospital the visit occurred. To locate the major hospitals in each community, we used Google.

Exclusions

We excluded: all claims assigned to facilities and other claims not labeled “professional”; providers with addresses listed at P.O. boxes; and provider addresses with fewer than 5 claims total in the three 18-month study periods.

We also excluded the following provider specialties:

- Ambulatory Surgi-Center
- Clinical Lab Participant
- Coordinated Home Health Care
- Detox facility
- DME home med equipment/respiratory
- Free-standing ambulance
- Heading Aid Vendor

Home health care
Home Infusion
Independent Physiological and Diagnostics Lab
Individual Case Management
Pharmacy (participation)
Physiological Lab
Sleep testing facility
Surgical day care center
Community health center

Core specialties

We designated the provider numbers that were listed with the following specialties as “core” and only used claims assigned to those numbers in the portion of our analysis focused on core providers:

Allergy & Immunology
Anesthesiology
Anesthetist (certified registered nurse)
Cardiovascular Disease
Cardio-thoracic Surgery
Certified Nurse Midwife
Clinical Nurse Specialist
Colon & Rectal Surgery
Dermatology
Emergency Medicine
Endocrinology
Family Practice
Gastroenterology
General Practice
General Surgery
Geriatric
Gynecological Oncology
Hand Surgery

Hematology/Oncology
Hospital Based Anesthesiologists
Infectious Diseases
Internal Medicine
IVF
Maternal & Fetal Medicine
Nephrology
Neurology
Neurological Surgery
Neonatal/Perinatal Medicine
Nurse Practitioner
Obstetrics & Gynecology
Ophthalmology
Oral & Maxillofacial Surgery
Orthopedic Surgery
Otolaryngology
Pediatrics and all pediatric sub-specialties
Physician Assistant
Physical Medicine & Rehabilitation
Plastic surgery
Pulmonary Disease
Psychiatry
Psychopharmacology
Reproductive Endocrinology
Rheumatology
Therapeutic Radiology
Urology
Vascular Surgery

Non-core specialties

We designated the provider numbers that were listed with the following specialties as “non-core” and only used claims assigned to those numbers in the portion of our analysis in which we included all providers (core and non-core):

Acute Care Hosp/Diagnostic Imaging
Anatomoc/Clinical Pathology
Audiologist
Chiropractic
Chronic disease hospital
Clinical Psychology
Diagnostic imaging
Diagnostic Radiology
Dietary Nutritionist
Early intervention
Endodontics
General Dentistry
Hematologic Pathology
Hospital Based Pathologists
Hospital Based Radiologists
Hospital (VA)
Hospice
Licensed Mental Health Counselor
LICSW
Multispecialty
Neuropathology
Occupational Therapists
Optometry
Orthodontics
Periodontics
Physical Therapy
Podiatry
Prosthodontics
Radiology
Speech Therapists

5.8 Appendix – additional results

The results of the simulations for all providers and summaries of the results of all three study periods are summarized in the figures and tables below. The results when including all specialties were similar to the results with only core specialties. The results of the simulation varied minimally over the three study periods.

For simulation 1, when including all specialties, even more mergers would have to take place for the potential utility to decrease by more than 50%: between 8 and 48 mergers were required.

For simulation 2, when including all specialties, community 2 appears to be an outlier in that it required many more groups in order to retain the HIE's utility in the event of substantial consolidation. This may represent an artifact of the simulation heuristic we used: large number of practices with high visits volumes but low transition percentages (e.g. children's mental health facilities) would be the last to merge in this simulation, but they may involve many care transitions may therefore not be very important to the HIE. Other possible explanation is that community 2 contains many small practices of comparable size and similar volumes of care transitions.

The key groups varied to some extent between core and all specialties. When including all specialties, hospitals were involved in the most transitions in every community, which probably is due to the effect of radiology and pathology.

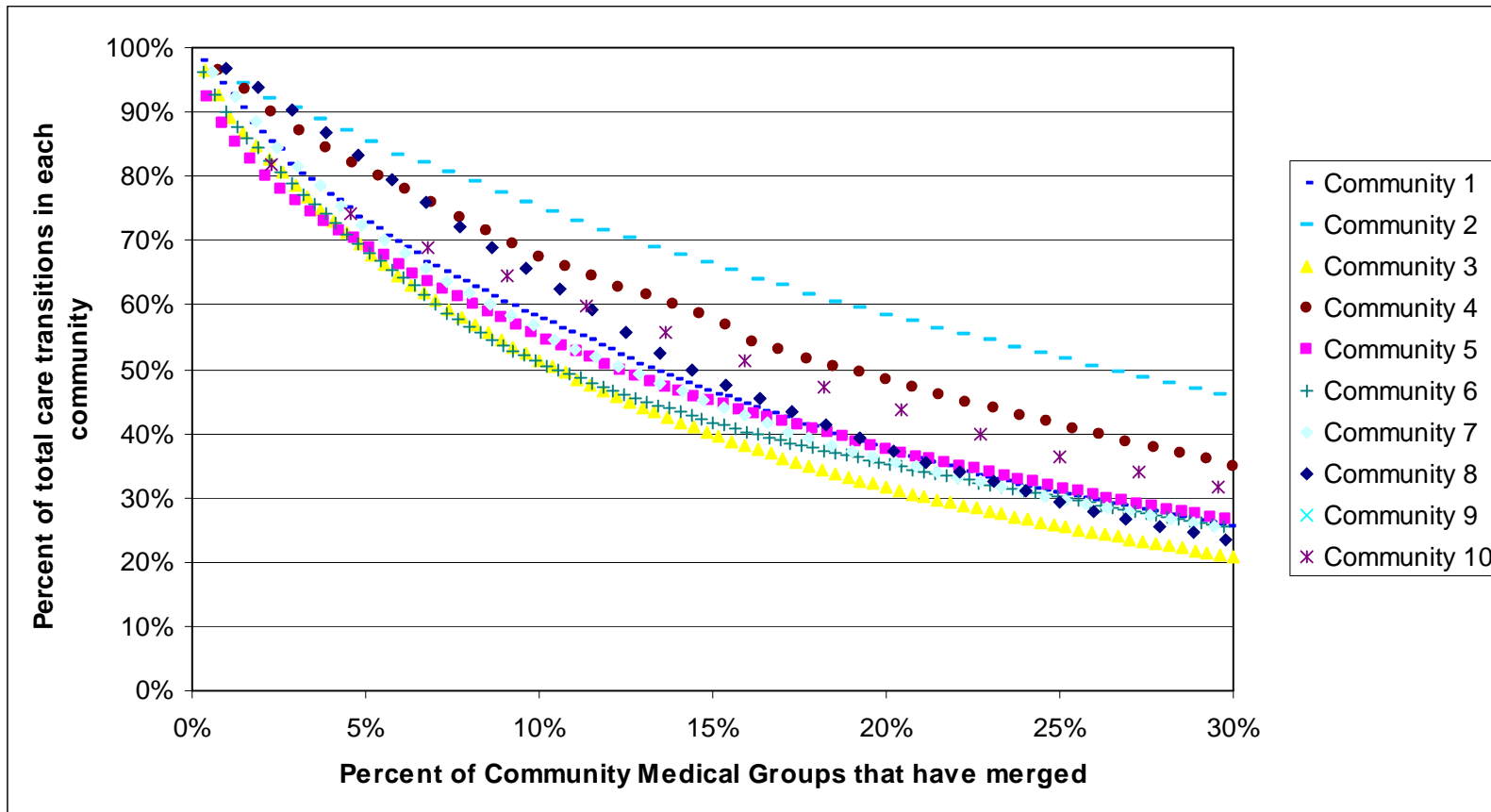


Figure 5.6 Larger mergers (simulation 1, for all specialties).

This pattern simulates the effect of mergers of medical groups on the potential value of community HIEs. Groups are chosen to merge based on the pairs of groups with the most care transitions between them and so the first merger has the largest effect. The data include all specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

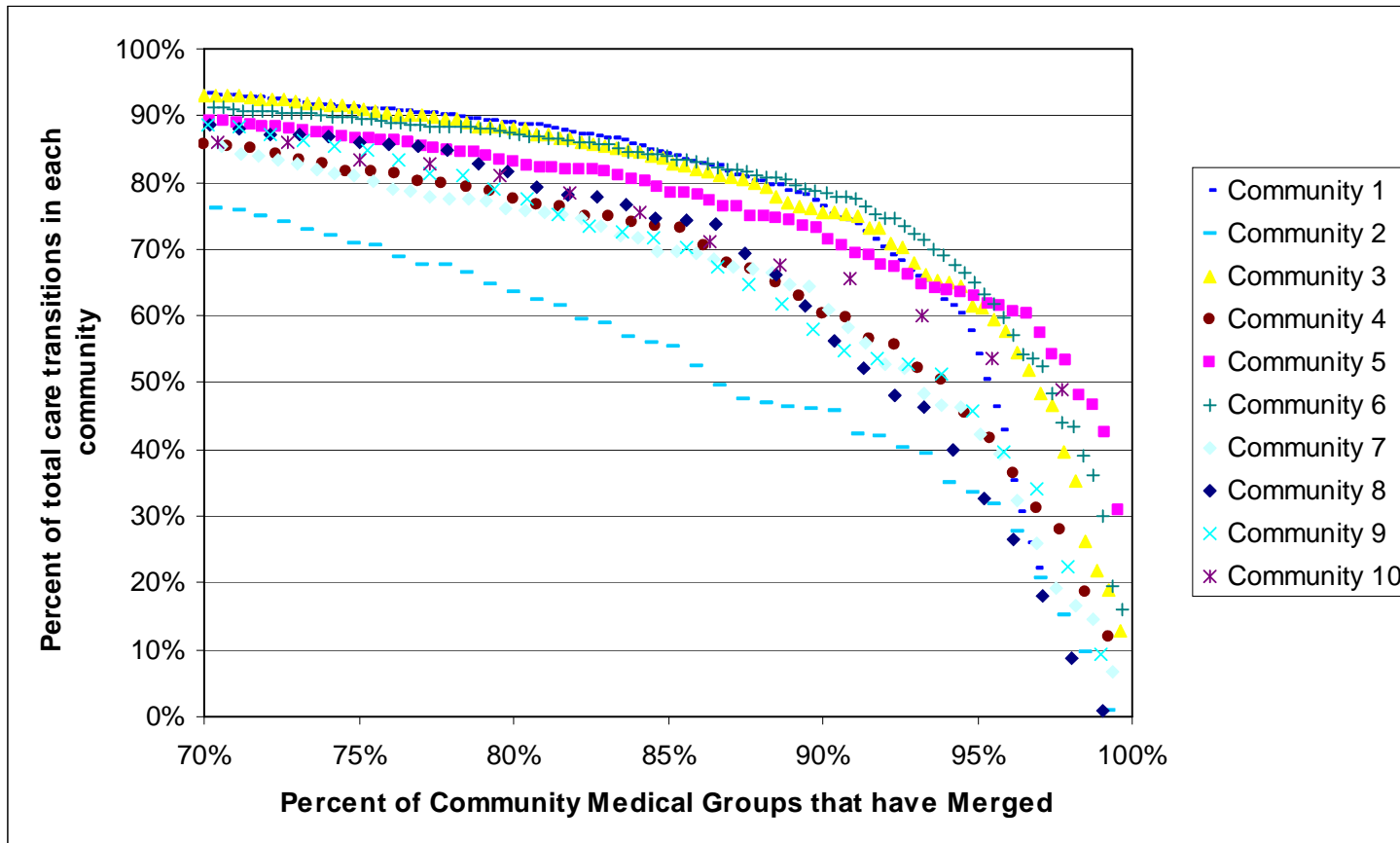


Figure 5.7 Small mergers (simulation 2, for all specialties).

This pattern simulates the effect of mergers of medical groups on the potential value of community HIEs. Groups with the smallest visit volumes are chosen to merge with the group with whom they share the most care transitions and so the first mergers tend to have small effects. The data include all specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

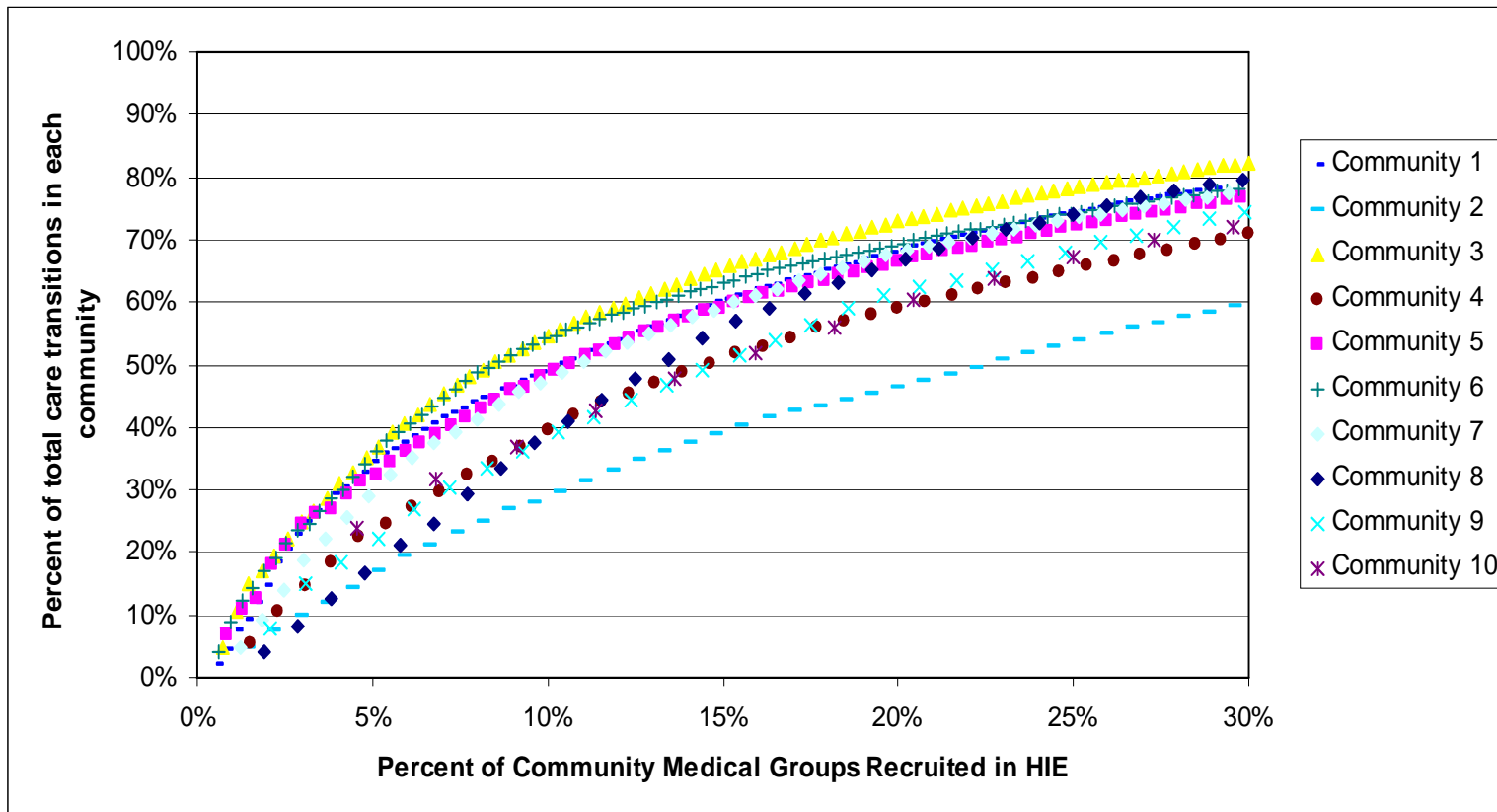


Figure 5.8 Recruitment (simulation 3, for all specialties).

This pattern simulates the effect of medical group participation in community HIEs on the potential value of the HIEs beginning with one group participating. The sequence of groups is determined by decreasing volume of care transitions in each community. The data include all specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

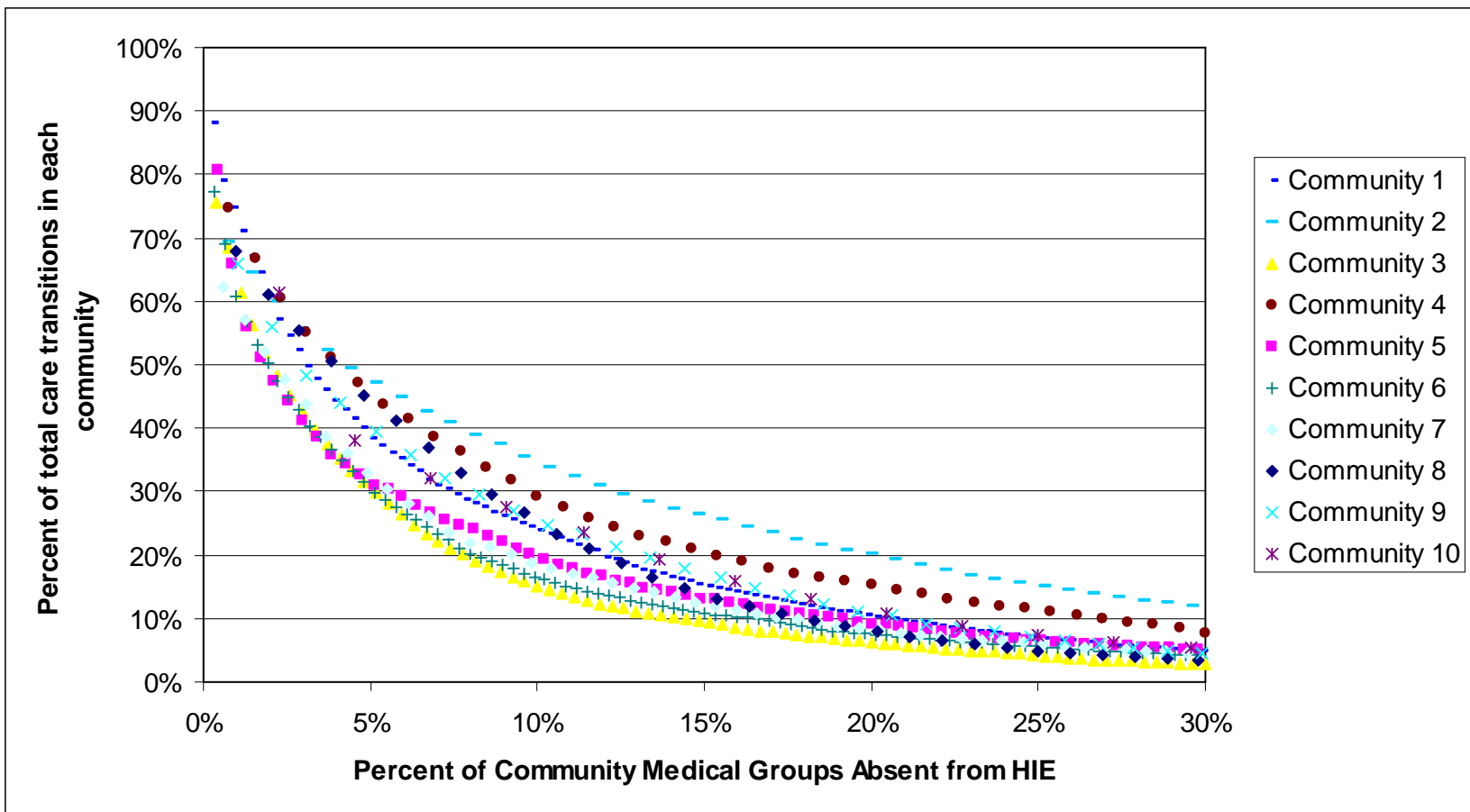


Figure 5.9 Retention (simulation 4, for all specialties).

This pattern simulates the effect of the absence of medical groups from community HIEs on the potential value of the HIEs beginning with full participation. The sequence of groups is determined by decreasing volume of care transitions in each community and so the first group has the largest effect. The data include all specialties and patient visits from January 1st 2005 through June 30th 2006. (Note: The x-axis represents a contrived pattern of variation in medical group mergers, and does not represent time. Every data point simulates all patient visits for the entire the study period.)

Community ²	No. patients	No. visits ³	Visits/patient	No. transitions	Transition percentage ⁴	HHI	No. groups
1	57,343	459,754	8.02	241,604	52.55%	0.0224	358
2	22,974	157,231	6.84	59,822	38.05%	0.0281	135
3	60,336	305,283	5.06	122,242	40.04%	0.0324	270
4	23,324	199,470	8.55	105,850	53.07%	0.0375	130
5	66,273	364,460	5.50	141,493	38.82%	0.0335	235
6	68,252	381,083	5.58	151,966	39.88%	0.0295	313
7	49,963	240,409	4.81	85,963	35.76%	0.0458	163
8	21,774	128,878	5.92	50,301	39.03%	0.0415	104
9	22,048	133,367	6.05	52,864	39.64%	0.0555	97
10	10,550	83,900	7.95	41,900	49.94%	0.1047	44
median[min- max]	36,643.5[10,550- 68,252]	219,939.5[83,900- 459,754]	5.98[4.81- 8.55]	95,906.5[41,900- 241,604]	39.76%[35.76%- 53.07%]	0.0355[0.0224- 0.1047]	149[44- 358]

Table 5.4 Community characteristics table (all specialties).¹

1. Includes visits to core specialties from patients who were fully enrolled with one private payer from January 1st 2005 until June 30th 2006.
2. Communities are presented here in the same order as in the main text, which was determined by increasing order of Herfindahl-Hirschman for core specialties only.
3. Excludes each patient's initial visit in the study period because there is no way to determine if that visit involved a care transition.
4. Transition percentage is defined as the percent of total visits to community providers for which the patient's previous visit was to a different medical group in the community.

		S1		S2		S3		S4		No. group absences which would reduce potential HIE usage by > 50% ^{5,6}
Community ¹	No. groups ²	No. big mergers which would reduce potential HIE usage by > 25% ³	No. big mergers which would reduce potential HIE usage by > 50% ³	No. consolidated groups needed for potential HIE to be > 30% ⁴	No. consolidated groups needed for potential HIE to be > 50% ⁴	No. groups needed to participate to achieve 15% potential HIE usage ^{5,6}	No. groups needed to participate to achieve 50% potential HIE usage ^{5,6}	Reduction in potential HIE usage from absence of 2 groups ^{5,6}	Reduction in potential HIE usage from absence of 5 groups ^{5,6}	
1	358	16	48	4	8	8	37	21.01%	32.83%	11
2	135	14	36	7	20	7	31	35.38%	47.69%	6
3	270	10	29	6	10	4	23	31.45%	47.88%	6
4	130	10	25	5	9	5	19	33.18%	48.85%	6
5	235	8	29	2	6	5	25	34.22%	52.46%	5
6	313	12	33	5	10	6	27	30.92%	46.95%	7
7	163	8	21	7	13	5	18	42.84%	56.38%	4
8	104	8	15	6	10	5	14	38.84%	54.78%	5
9	97	7	16	4	7	3	15	43.90%	60.56%	3
10	44	2	8	2	3	2	7	62.02%	76.44%	2
median[min- max]	36,643.5[10,550- 68,252]	9.[2-16]	27.[8-48]	5.[2-7]	9.5[3-20]	5.[2-8]	21.[7-37]	34.80%[21.01%- 62.02%]	50.65%[32.83%- 76.44%]	5.5[2-11]

Table 5.5 Summary results (all specialties from January 1st 2005 until June 30th 2006)

1. Communities are presented here in the same order as in the main text, which was determined by increasing order of Herfindahl-Hirschman for core specialties only.
2. No. groups are those that constitute 99% of community care transitions.
3. The sequence of mergers was decreasing by number care transitions between the pairs of medical groups in each geographic community.
4. Consolidation was simulated by iteratively merging groups that had the smallest visit volumes into the groups with which they shared the most care transitions.
5. The sequence of the groups is decreasing by volume of care transitions in each geographic community.
6. The denominator for these percentages is the potential HIE usage for the study period in each community assuming complete participation and no mergers i.e. the total number of care transitions between groups during the study period.

Community	No. key groups ¹	Percent of total groups that are key groups ²	Key group descriptions ³	HIE value with key groups only (Simulation 3)	Decrease in potential value of HIE if key groups do not participate (Simulation 4) ⁴
1	11	3.07%	Hospital, Multispecialty, Hospital, Multispecialty, Dermatology, Multispecialty, Radiology, Pathology, Orthopedic Surgery, Primary care & Pediatrics, Multispecialty	24.84%	50.31%
2	6	4.44%	Hospital, Primary care, Primary care, Multispecialty, Pediatrics, Primary care	14.47%	50.48%
3	6	2.22%	Hospital, Multispecialty, Hospital, Multispecialty, Pediatrics, Orthopedic surgery	19.37%	51.70%
4	6	4.62%	Hospital, Primary care, Primary care, Ophthalmology, Orthopedic Surgery, Obstetrics & Gynecology	22.57%	52.92%
5	5	2.13%	Hospital, Multispecialty, Hospital, Primary care, Primary care	18.10%	52.46%
6	7	2.24%	Hospital, Multispecialty, Multispecialty, Multispecialty, Primary care, Orthopedic Surgery, Primary care & Pediatrics	19.10%	52.63%
7	4	2.45%	Hospital, Orthopedic Surgery, Multispecialty, Primary Care	14.13%	52.16%
8	5	4.81%	Hospital, Primary care & Pediatrics, Primary care, Orthopedic Surgery, Primary care	16.84%	54.78%
9	3	3.09%	Hospital, Multispecialty, Multispecialty	15.03%	51.61%
10	2	4.55%	Hospital, Multispecialty	23.98%	62.02%
median[min- max]	5.5[2-11]	3.08%[2.13%-4.81%]	N/A	18.60%[14.13%- 24.84%]	52.31%[50.31%- 62.02%]

Table 5.6 Key medical groups (all specialties, for visits from January 1st 2005 until June 30th 2006).

1. Key groups are those involved in the most care transitions in the community and would limit HIE value to <50% of potential if they did not participate.

2. Total groups are those that constitute 99% of community care transitions.

3. The group descriptions are ordered from those involved in the most community care transitions to the least. 4. Assumes all non-key groups participate in HIE

Community2	No. patients[min- mix]	No. visits3 [min- max]	Visits/patient [min-max]	No. transitions [min-max]	Transition percentage [min-max]4	HHI [min- max]
1	[44,301- 51,434]	[242,954- 295,460]	[5.48-5.79]	[113,328- 138,114]	[45.76%- 46.75%]	[.0221- .0228]
2	[19,436- 22,098]	[88,470- 97,068]	[4.25-4.55]	[29,817- 31,388]	[31.98%- 33.7%]	[.0311- .0329]
3	[46,911- 51,802]	[191,828- 207,770]	[4.-4.09]	[70,662- 76,035]	[36.6%- 36.84%]	[.0372- .039]
4	[18,545- 20,538]	[110,495- 126,028]	[5.96-6.14]	[55,372- 63,139]	[49.44%- 50.11%]	[.0361- .0394]
5	[49,040- 54,139]	[217,304- 236,462]	[4.37-4.43]	[69,767- 79,958]	[30.83%- 35.29%]	[.038- .0401]
6	[56,799- 67,774]	[225,887- 270,034]	[3.96-3.98]	[81,857- 96,909]	[35.89%- 36.24%]	[.0405- .0484]
7	[40,001- 46,690]	[144,048- 166,589]	[3.33-3.6]	[45,273- 51,762]	[31.07%- 32.84%]	[.0387- .0413]
8	[17,896- 20,838]	[70,856- 82,633]	[3.7-3.97]	[30,783- 35,536]	[43.%- 44.35%]	[.0444- .0455]
9	[16,740- 18,864]	[74,331- 80,687]	[4.11-4.52]	[22,532- 23,846]	[29.55%- 30.46%]	[.0661- .0725]
10	[9,464- 9,856]	[50,679- 54,395]	[5.31-5.54]	[22,767- 23,596]	[43.38%- 45.18%]	[.1195- .1421]

Table 5.7 Range of community characteristics over three study periods (core specialties).1

1. Includes visits to core specialties from patients who were fully enrolled with one private payer during three 18-month study periods from January 1st 2005 until June 30th 2009.

2. Communities are presented here in the same order as in the main text, which was determined by increasing order of Herfindahl-Hirschman for core specialties only.

3. Excludes each patient's initial visit in the study period because there is no way to determine if that visit involved a care transition.

4. Transition percentage is defined as the percent of total visits to community providers for which the patient's previous visit was to a different medical group in the community.

Community2	Simulation 1		Simulation 2		Simulation 3		Simulation 4		No. group absences which would reduce potential HIE usage by > 50% [min-max]5,6
	No. cumulative mergers which would reduce potential HIE usage by > 25% [min-max]7	No. cumulative mergers which would reduce potential HIE usage by > 50% [min-max]7	No. consolidated groups needed for potential HIE to be > 30% [min-max]8	No. consolidated groups needed for potential HIE to be > 50% [min-max]8	No. groups needed to participate to achieve 15% potential HIE usage [min-max]5,6	No. groups needed to participate to achieve 50% potential HIE usage [min-max]5,6	Reduction in potential HIE usage from absence of 2 groups [min-max]5,6	Reduction in potential HIE usage from absence of 5 groups [min-max]5,6	
1	[18-20]	[41-43]	[3-4]	[4-7]	[8-9]	[35-36]	[16.08%-17.66%]	[34.27%-35.12%]	[10-11]
2	[12-14]	[24-29]	[3-4]	[6-9]	[7-8]	[23-27]	[26.4%-28.01%]	[43.93%-46.51%]	[7-7]
3	[12-12]	[25-25]	[4-5]	[7-7]	[7-7]	[22-23]	[22.97%-23.37%]	[40.93%-41.49%]	[8-8]
4	[8-9]	[17-17]	[2-4]	[4-6]	[5-5]	[15-15]	[28.57%-29.43%]	[51.15%-52.59%]	[5-5]
5	[10-13]	[23-29]	[4-6]	[7-7]	[6-8]	[22-26]	[23.7%-25.91%]	[43.09%-45.48%]	[6-7]
6	[10-11]	[21-22]	[3-4]	[4-5]	[6-6]	[19-20]	[25.12%-26.66%]	[46.53%-49.71%]	[6-6]
7	[8-9]	[18-19]	[6-6]	[7-8]	[6-6]	[16-17]	[26.97%-28.35%]	[50.81%-54.38%]	[5-5]
8	[8-9]	[14-14]	[4-5]	[7-8]	[6-6]	[13-13]	[27.78%-30.12%]	[49.83%-51.7%]	[5-6]
9	[6-7]	[12-13]	[3-3]	[4-6]	[4-5]	[12-13]	[37.12%-38.64%]	[62.36%-64.5%]	[3-3]
10	[2-3]	[6-7]	[2-2]	[3-4]	[2-2]	[6-7]	[59.56%-63.52%]	[80.92%-82.35%]	[2-2]

Table 5.8 Range of results (core specialties from January 1st 2005 until June 30th 2009)

1. Communities are presented here in the same order as in the main text, which was determined by increasing order of Herfindahl-Hirschman for core specialties only.
2. No. groups are those that constitute 99% of community care transitions.
3. The sequence of mergers was decreasing by number care transitions between the pairs of medical groups in each geographic community.
4. Consolidation was simulated by iteratively merging groups that had the smallest visit volumes into the groups with which they shared the most care transitions.
5. The sequence of the groups is decreasing by volume of care transitions in each geographic community.
6. The denominator for these percentages is the potential HIE usage for the study period in each community assuming complete participation and no mergers i.e. the total number of care transitions between groups during the study period.

Community ²	No. patients [min-mix]	No. visits ³ [min-max]	Visits/patient [min-max]	No. transitions [min-max]	Transition percentage [min-max] ⁴	HHI [min-max]
1	[50,386-57,343]	[393,261-459,754]	[7.8-8.1]	[207,692-241,604]	[51.98%-52.81%]	[.0193-.0224]
2	[22,974-26,724]	[157,231-176,744]	[6.61-6.84]	[59,822-64,300]	[36.38%-38.05%]	[.0252-.0281]
3	[60,336-67,218]	[305,283-341,347]	[5.06-5.15]	[122,242-134,231]	[39.09%-40.04%]	[.0311-.0324]
4	[21,221-23,324]	[195,399-202,934]	[8.55-9.21]	[104,121-108,752]	[53.07%-53.59%]	[.0359-.0375]
5	[66,273-77,069]	[364,460-399,199]	[5.1-5.5]	[138,439-152,268]	[36.04%-38.82%]	[.0285-.0335]
6	[68,252-82,465]	[381,083-474,143]	[5.58-5.8]	[151,966-184,615]	[38.94%-39.88%]	[.0267-.0295]
7	[49,963-61,891]	[240,409-287,491]	[4.62-4.82]	[85,963-100,974]	[34.66%-35.76%]	[.0458-.0529]
8	[21,774-26,829]	[128,878-153,500]	[5.72-5.92]	[50,301-59,064]	[37.67%-39.03%]	[.0369-.0428]
9	[22,048-27,778]	[133,367-158,103]	[5.69-6.05]	[52,864-61,104]	[38.01%-39.64%]	[.0482-.0555]
10	[10,070-10,550]	[83,900-84,865]	[7.95-8.33]	[41,900-44,666]	[49.94%-52.63%]	[.0784-.1047]

Table 5.9 Range of community characteristics over three study periods (all specialties).¹

1. Includes visits from patients who were fully enrolled with one private payer during three 18-month study periods from January 1st 2005 until June 30th 2009.
2. Communities are presented here in the same order as in the main text, which was determined by increasing order of Herfindahl-Hirschman for core specialties only.
3. Excludes each patient's initial visit in the study period because there is no way to determine if that visit involved a care transition.
4. Transition percentage is defined as the percent of total visits to community providers for which the patient's previous visit was to a different medical group in the community.

Community2	Simulation 1		Simulation 2		Simulation 3		Simulation 4		No. group absences which would reduce potential HIE usage by > 50% [min-max]5,6
	No. cumulative mergers which would reduce potential HIE usage by > 25% [min-max]7	No. cumulative mergers which would reduce potential HIE usage by > 50% [min-max]7	No. consolidated groups needed for potential HIE to be > 30% [min-max]8	No. consolidated groups needed for potential HIE to be > 50% [min-max]8	No. groups needed to participate to achieve 15% potential HIE usage [min-max]5,6	No. groups needed to participate to achieve 50% potential HIE usage [min-max]5,6	Reduction in potential HIE usage from absence of 2 groups [min-max]5,6	Reduction in potential HIE usage from absence of 5 groups [min-max]5,6	
1	[16-19]	[48-54]	[3-5]	[8-9]	[8-8]	[37-41]	[17.88%-21.01%]	[30.03%-32.83%]	[11-13]
2	[14-17]	[36-43]	[7-8]	[18-20]	[7-8]	[31-37]	[32.12%-35.38%]	[44.89%-47.69%]	[6-7]
3	[10-12]	[29-33]	[6-6]	[10-11]	[4-5]	[23-27]	[30.86%-31.45%]	[45.7%-47.88%]	[6-7]
4	[10-12]	[25-30]	[5-6]	[9-11]	[5-5]	[19-23]	[32.43%-33.18%]	[46.77%-48.85%]	[6-6]
5	[8-13]	[29-40]	[2-3]	[5-6]	[5-6]	[25-33]	[29.76%-34.22%]	[50.48%-52.5%]	[5-5]
6	[12-13]	[33-40]	[2-5]	[7-10]	[6-7]	[27-32]	[28.34%-30.92%]	[44.22%-46.95%]	[7-7]
7	[7-8]	[20-21]	[7-7]	[11-13]	[4-5]	[17-18]	[42.84%-45.92%]	[56.38%-59.79%]	[3-4]
8	[8-9]	[15-18]	[6-8]	[10-12]	[5-5]	[14-16]	[35.53%-38.84%]	[50.88%-54.78%]	[5-5]
9	[7-8]	[16-23]	[4-4]	[7-9]	[3-4]	[15-19]	[40.68%-43.9%]	[57.13%-60.56%]	[3-4]
10	[2-4]	[8-11]	[2-2]	[3-4]	[2-2]	[7-10]	[52.49%-62.02%]	[68.86%-76.44%]	[2-2]

Table 5.10 Range of results (all specialties from January 1st 2005 until June 30th 2009)

1. Communities are presented here in the same order as in the main text, which was determined by increasing order of Herfindahl-Hirschman for core specialties only.
2. No. groups are those that constitute 99% of community care transitions.
3. The sequence of mergers was decreasing by number care transitions between the pairs of medical groups in each geographic community.
4. Consolidation was simulated by iteratively merging groups that had the smallest visit volumes into the groups with which they shared the most care transitions.
5. The sequence of the groups is decreasing by volume of care transitions in each geographic community.
6. The denominator for these percentages is the potential HIE usage for the study period in each community assuming complete participation and no mergers i.e. the total number of care transitions between groups during the study period.

Chapter 6 HIE and other changes in the healthcare system

6.1 Abstract*

Health information exchange is embedded in the larger healthcare system. We identify a number of healthcare system changes that may overcome the barriers to HIE adoption and usage, including changes in the incentives that providers face. We also discuss how HIE may be an important component of some of those changes, reflecting a possible chicken-egg dilemma. It is unknown which changes will actually work to improve adoption and usage of HIE and we recommend that all of them be tried and evaluated.

6.2 Introduction

The previous chapters of this thesis have deepened extant knowledge of healthcare providers' adoption and usage of HIE, knowledge of both provider organizations' values and of individual clinicians' experiences with HIE. Informed by these investigations, we have offered several near-term policy recommendations, directed mostly at the remaining stages of the meaningful use payments and how to establish a robust HIE infrastructure. This chapter considers these policy recommendations in a larger context by evaluating them alongside other potential changes in the healthcare system, changes which may also have a substantial impact on HIE adoption and usage. These changes include: patient-centered medical home pilots, accountable care organizations, improvements in quality measures, and increases in patient demand for HIE. We evaluate the strengths and weaknesses of these changes by assessing how they may impact the many barriers of HIE adoption and usage that have been identified in this thesis and in previous studies. Figure 6.1 summarizes the chapter by mapping the healthcare system changes to the barriers of HIE adoption and usage which the changes may affect.

* Much of the contents of this chapter was published in: "The Litmus Test for Health Information Exchange Success: Will Small Practices Participate?" Invited Commentary, *Arch Intern Med.*, 2010

Health system changes: Barriers to HIE adoption and usage:	Meaningful use payments (for usage and training)	Technology standards, certification of EHRs and HIE products	Patient-based medical home	Quality measures for care coordination	Accountable care organizations	Patient demand for HIE
Medical groups (HIE adoption):						
Technology issues (e.g. installing and maintaining)	X	X				
Cost		X				
Lack of financial benefit	X		X	X	X	X
Concerns of sharing data with competitors				X	X	
Privacy concerns		X				X
Individual clinicians (HIE usage):						
Incompleteness of HIE data	X	X	X	X	X	X
Technical usability issues		X				
Integrating HIE into clinical workflow	X	X	X	X	X	X

Figure 6.1: How other changes in the health care system may address barriers to HIE adoption and usage

6.3 Technology standards and certification of health IT products

Since 2004, the Office of the National Coordinator for Health IT has worked to establish and harmonize standards for technical interoperability and to certify EHR and HIE products based on their adherence to these standards. It is unlikely that technical standards will advance in the near future to the point where EHRs and HIE are “plug and play” because of the complexity of health information data models, use cases and workflows, and in particular challenges

related to semantic interoperability. However, these standards have the potential to reduce the technical barriers to integrating EHRs with HIEs and reduce providers' uncertainty when selecting health IT products. Ideally, technical standards and certification would engender competition among EHR vendors based on interoperability and leave behind business strategies aimed at locking doctors and patients in to proprietary systems. However, if the standards are not granular or do not include semantic standards, they may provide only minimal benefit. Standards also run the risk of reducing innovation in data models and increasing entry barriers for new EHR products; however, considering the relatively low adoption of EHRs and HIE, standardization may be worth these risks.

The ONC-sponsored Direct Project (formerly NHIN Direct) has recently issued standards related to point-to-point communication among healthcare providers. [50] This kind of data exchange may be especially useful when patients receive care in different geographical communities, data exchanges which would not be possible in regional data sharing services. As we point out in chapter 3, however, if these standards and related policies are not integrated with more advanced forms of HIE, such as aggregate patient records, they may undermine the adoption of these advanced forms of HIE, because providers may find the point-to-point communication sufficient for their needs, even when they have access to aggregate patient records for local patient. If providers are not willing to pay for advanced data exchange services, HIEs will stop investing in them, even though the advanced services may support substantial improvements in clinical care by offering, for example, the ability to search and query longitudinal patient records and patient portals.

While technical standards may be necessary to foster HIE, they will probably not be sufficient, because the costs of operating an HIE will still be significant and providers' incentives to adopt and use HIE will remain largely unchanged.

6.4 Meaningful use payments

The \$27 billion of payments for meaningful use of health IT have the potential to greatly increase EHR adoption and HIE participation in the near term.

If targeted as we suggest in this thesis, these incentives may also increase individual clinicians' usage of aggregate patient records, either by directly paying clinicians for contributing to and accessing the HIE, or indirectly through payments to HIE organizations or regional health IT extension centers to motivate them to help clinicians integrate HIE services into their workflows.

One possible advantage of the meaningful use payments to clinicians is they may pay for HIE usage directly. The payments may also create a more competitive marketplace for HIE services and generate more investment in HIE technology, which may result in improvements in usability and fewer technical issues. However, the risk of paying directly for usage (or any measure of clinical process instead of outcome) is gaming: clinicians may access an HIE only to receive the incentive payments rather than for clinical purposes. Meaningful use metrics will at best be approximations of the measures that are of interest to policymakers, measures related to care quality and health outcomes. Whether gaming is a serious concern is a question that must be addressed empirically. Payments to regional health IT extension centers based on clinicians' HIE usage may not suffer from potential problems of gaming but these centers may have limited influence on changing clinician's workflows to integrate HIE.

Gaming aside, the meaningful use payments alone may not be large enough to overcome the barriers to adoption of EHRs and HIE, especially for small providers who lack the resources to devote to installing and managing new software systems and training clinicians to use them.[111] [112] One study of HIE participation in small primary care practices in Minnesota in 2008-9 found that "no practice was fully involved in a regional HIE and HIE was not part of most practices' short-term strategic plans." [112] Because small primary care practices provide a large portion of care in many regions, they represent critical stakeholders to HIEs. These stakeholders, however, may be the hardest group to engage in HIEs because of their difficult financial situations and large patient loads.[110] Small primary care practices therefore may represent the litmus test for the success of HIE.

If a substantial number of providers have not met the meaningful use requirements by 2016, when the penalties go into effect, providers may attempt to have the penalties delayed or rescinded through lobbying. There is currently no mechanism established to pay for HIE after the meaningful use payments run out. While it is possible that accessing an HIE will become the standard of care

eventually, if the incentives that providers face are the same in the future as they are today, HIE adoption and usage will likely remain low.

6.5 Patient-centered medical homes

The Affordable Care Act of 2010 includes a provision to create patient-centered medical homes. These pilots involve enhancing the responsibilities of primary care physicians to include strong partnerships with the patient and their care givers. If enacted on a large scale, patient-centered medical homes may increase demand for HIE by making payments to primary care providers to “support coordination of care” between providers and the “use of health information technology for quality improvement.” [89] A number of demonstration pilots are under way.[113] However, it has not been shown empirically that providers who participate in these pilots are more likely to participate in and use HIEs. Also, the medical homes projects do not include any extra payments to specialist physicians, many of whom may still not adopt HIE. Further research is required to understand the impact of these projects on HIE adoption and usage.

6.6 Quality measures for care coordination

As stated in Chapter 1, health IT and quality measurement may be stuck in a chicken-egg dilemma: health IT is required to create better quality measurements by allowing clinical data to be effectively aggregated, but the development of better quality metrics requires health IT to be adopted first. Once health IT becomes adopted to a sufficient degree – possibly because of the meaningful use payments – quality measures may evolve so that providers will be motivated to engage in HIE to improve their quality scores, especially those scores related to coordination of care. Consistent with our findings in chapter 2, one study found that quality reporting was a “frequently mentioned motivation for establishing HIEs.” [112] If HIEs are adequately designed to support quality measurements, and those measurements are expanded to become more comprehensive, quality-based performance payments may have the potential to

pick up where the meaningful use payments leave off. One study assesses extant metrics for their sensitivity to health IT usage and suggests several de novo metrics that specifically require HIE. [39] However, there are many challenges to using clinical data for quality measurement purposes including data accuracy, data completeness, and data comparability. [114].

Another challenge to quality measurement is determining a suitable level of analysis. Recent studies show that episode-based metrics for physician cost profiling may not achieve sufficient reliability for many individual physicians and quality ratings may need to be computed for medical groups instead. [115] [116] This may best occur in the form of accountable care organizations, which we discuss next.

6.7 Accountable care organizations

The Affordable Care Act of 2010 allows for the creation of accountable care organizations (ACO). An ACO is a group of providers who accept accountability for the cost and quality of a specific group of patients. [88] [117] ACOs and HIEs will have an interest in working together. If ACOs believe that HIE will reduce costs or improve quality, they will participate in HIEs and encourage their clinicians to use the data exchange services. They may also use the HIE to help with quality measurement. Conversely, HIEs will look to ACOs to help them achieve sustainability.

It is unknown how HIEs and ACOs will co-evolve. In many instances, they may become the same organization and HIEs will facilitate data sharing within an ACO. In other cases, an ACO may utilize an HIE's services for internal or external data sharing but retain separate ownership and management.

While there may be different variants of ACO, the ones that accept the most accountability are likely to engage in data sharing activities as evidenced by the experience of Kaiser Permanente. Because Kaiser is an integrated payer and provider, it essentially is an ACO that accepts all responsibility for cost and quality, and Kaiser is leading the way in health data sharing. [118] Therefore, it is likely that ACOs, and their use of quality metrics, will ease provider concerns regarding sharing data with competitors and, indeed, will actively foster HIE by facilitating improvements in providers' quality scores.

6.8 Patient demand for HIE

Market forces may play a role in fostering adoption and usage of HIE. A RAND study advises the government to “make policy decisions that turn [healthcare] IT into a competitive weapon.” [15] Unfortunately, with today’s shortage of primary care providers, few will think to use HIE as a competitive weapon to attract new patients, as many already have full panels. [15][119] It is unknown the extent to which patients may choose a provider based on their HIE adoption or if providers will respond to such demand from patients. One HIE project has focused on outreach to educate health care consumers about the benefits of clinical data exchange.[111] However, because patients are generally not involved in provider-provider data exchange, it may be unlikely that many patients would think to choose a physician based on their participation in an HIE or even know which physicians were involved in HIEs.

Patient demand for HIE may grow when patients come to expect access to their own health data in an organized electronic form: when HIEs offer patient portals, allowing them to view and manipulate data from their providers and clearly see which providers are participating and which are not. If HIEs advance to the point where patients can access their own clinical data, market forces – in the form of patients’ expectations – may become strong enough to bring providers toward HIEs.

Another form of HIE may happen if EHRs connect directly to personally-controlled health records (PCHR), bypassing HIE organizations altogether. This form of HIE would involve the patient controlling and managing their health data. Indivo, Google Health, Microsoft Health Vault are examples of products attempting to provide this kind of data exchange service. (Google Health recently announced that it was shutting down.) This form of HIE, however, has the disadvantage of requiring the patient to manage all of their own data exchanges. Ideally, a patient could have both: manage their own data in a PCHR and allow their clinicians to exchange data among themselves directly via an HIE if the patient chooses to allow such exchanges. Having this capability may motivate the patient to choose providers who use these kinds of products.

6.9 Conclusion

As shown in figure 6.1, all of the barriers to HIE may be addressed by changes in the healthcare system, many of which are currently being piloted. Because none of these changes have been demonstrated empirically to have an impact on providers' adoption and usage of HIE, the figure should be considered as only a rough guide. We suggest that all the changes shown should be attempted where feasible and their impact on HIE should be studied empirically. Some changes will be more difficult to implement than others, and the success of any change in incentives may rest on the effectiveness of technical standards in fostering interoperability. We may have inadvertently missed some barriers to HIE or potential health system changes that may affect HIE adoption and usage.

In the short-term, the meaningful use payments may motivate many providers to adopt HIE, but some providers may still need even more direct subsidies or be allowed to contribute clinical data to HIEs for free and only pay for access to collected clinical data. In the long-term, HIE must be embedded in the larger healthcare system's incentive structures. When the meaningful use payments expire, if patient-based medical home projects, quality-based performance payments, ACOs and patient demand for HIE have not gained in influence, HIEs may still suffer from the difficulties of sustainability and attracting small providers that they grapple with today, and much of the potential benefit of HIE will not be realized.

Chapter 7 Conclusions

This thesis has answered, to some extent, the four questions we began with:

Question 1: What are the values of healthcare provider organizations as stakeholders in HIE?

Answer: In three communities, healthcare provider organizations expected regional HIE organizations to bring them benefits from the ability to measure care quality. However, one relatively larger community placed greater value on the strategic interests of its individual provider institutions, whereas two smaller communities valued the interests of the communities as a whole.

Question 2: What factors affect clinicians' usage of health information exchange?

Answer: Usage factors were categorized as motivators and moderators. Motivators for individual clinicians' usage of HIE included improving care quality and time savings. Moderators were numerous and included gaps in data, workflow complexity and usability issues. Several policy options and implications are discussed including: requiring HIE organizations to report metrics of HIE contributions and accesses; certifying HIE vendor companies to provide standardized usage metrics; and creating incentives for clinicians as well as HIE organizations and regional health IT extension centers to meet HIE usage targets.

Question 3: What is the potential value of HIE as measured by "care transitions?"

Answer: In one community, 51% of visits involved care transitions among individual providers, and 36-41% involved care transitions between medical groups. The percentage of a provider's visits which involved care transitions varied considerably by clinical specialty and even within specialties. Within primary care, individual clinicians' "transition percentages" varied from 32% to 95%.

Question 4: How do mergers and variation of provider participation affect an HIE's potential value?

Answer: Simulation patient visit patterns in 10 communities suggest that even after substantial consolidation of medical groups, an HIE would still have many opportunities for data exchange. However, in each community a small number of medical groups were key: if absent from a community HIE, these groups would reduce the value by 50%. Conversely, if they were the only groups participating, the HIE's value would only achieve 10-20% of its value with all groups participating.

This thesis has advanced the current understanding of health information exchange in several ways. Through qualitative methods, it has more deeply described the stakeholders' expectations and values regarding HIE, as reflected in organizational decisions and individual clinicians' usage of the technology. The simple framework of motivators and moderators may be useful to other researchers who are trying to understand the users of other kinds of technical functionality.

Through quantitative methods, it has shown how patient visit patterns, provider participation and medical group mergers may influence the potential value that HIE may provide. One of this thesis' largest contributions is showing that care transitions can be used as a measure of HIE value in that they represent opportunities for data exchange services to be used. This thesis has also shown that claims data may be useful for understanding an HIE as a system by extrapolating patient visit patterns from such data.

It is still unknown if HIE will succeed on a large scale in the U.S. or in any other country. This thesis suggests that focusing on technical aspects, while important, is not enough. Socio-technical aspects of healthcare delivery must be considered, including public policy, incentives, and clinical workflows. To succeed, there will likely need to be co-development of several of these components, and this thesis offers a few suggestions which involve all of the major stakeholders in HIE.

Further research is needed to understand the clinician-user and the system in which the users and the technology interact. Specifically, an improved knowledge of different kinds of care transitions would be essential to understanding the value of HIE and would allow improvements to our simulation model in Chapter 5. Such knowledge could also be used to inform the design of new technical functionalities beyond simple data exchange. HIE will evolve to

support richer forms of collaboration among clinicians and with patients. It will be important to understand and develop usage measures for these new functionalities so that they can be improved and so that researchers can investigate which forms of usage are most effective.

HIEs will present enormous opportunities for secondary uses, and development of those applications, especially applications related to quality analysis, may be essential to achieve sustainability in HIE organizations and improvements in healthcare delivery.

After decades of failed attempts, HIE may be on a path toward success, now that policymakers are engaged and have invested considerable resources. However, it may still take many years and experiments before HIE realizes even a modest portion of its potential. It will be important to learn from the successes and failures and to continue employing a systems perspective to understand HIE.

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