# Clinical Value-Add for Health Information Exchange (HIE)

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## **Abstract**

Objectives: We describe the clinical utility- both positive and negative- of Health Information Exchanges (HIE) in order to ascertain how true value can be attained through the adoption of such a system. Methods: We performed a literature review over multiple databases of 350 articles pertaining to the topic. After screening for relevance, we selected 135 articles that discuss studies pertaining to HIE. Results: We populated two tables with information synthesized form the 135 journal articles. One table focuses on the positive aspects of HIE, and the second table focuses on the negative aspects of HIE. Our focus is to highlight clear benefits, notable uncertainties, and position them in juxtapose to establish a clear comparison. Conclusions: Though HIE have both positive and negative aspects, one must focus on the specificities of the health institution, including patient volume, demographics, and health focus, in order to determine the value of implementing such a system.

## INTRODUCTION

Health Information Exchanges (HIE) are rapidly advancing as the next step in improving patient care using technological applications. HIE affect the fundamental patient care system by transforming how medical information is delivered and disseminated. Medicine in America has long been a fragmented field; and with the ever increasing amount of transactional volume of patient information, the need to integrate the system in a coherent manner becomes all the more imperative. However, intuitive benefits of such a system belie inherent risks in creating such a system. Adapting a large scale HIE creates logistical and patient safety related problems. Numerous government and private organizations have developed studies or simulations detailing both the positive and negative aspects of HIE. Published studies that demonstrate seemingly apparent benefits are often limited in nature and contingently specific. We perform a systematic review of the literature and present the information to obtain a comprehensive view of how truly effective HIE can be. We focus our review on the clinical implications of HIE systems.

From the available data, we extrapolate key parameters to construct a value-added table highlighting the benefits and risks or uncertainties of a HIE. We focus on those attributes which affect patient management, influence physician decision-making, and impact both short-term and long-term decision analyses.

## **METHODS**

We performed an indexed internet search using the following search engines: PubMed, Cochrane Database, and Google scholar. The searches took place June, July, August, and October of 2010. We began with the phrase, "Health Information Exchange (HIE)", and broadened the search terminology to include similar terminology associated with HIE, thus maximizing sensitivity. We reviewed the literature directly addressing studies and surveys conducted on the topic. Sources include independent consultant reviews, academic journals, and articles detailing academic based HIE initiatives. Our search catered to broad based studies pertinent to the general patient population, and not any specialty specific study. Although we did not distinguish set criteria for what constitutes our targeted practice, we took aims to distinguish the scope of each study to better assess its applicability in reflecting general populations.

Studies were mostly taken from academic published journals available through the search engines. However, a few private, consulting based studies were included in the study, but denoted as such.

Data was extracted from the study, synthesized, and integrated into descriptive excerpts detailing key points. We populated the data within a two dimensional matrix highlighting key clinical parameters. Clinical parameters and the associated benefits included are commonly accepted metrics used to gauge improvements upon implementing

EMR/EHR.<sup>1</sup> A literature search and expert review at the Chicago Health Information Technology Regional Extension Center (CHITREC) helped establish the framework of the matrix. The clinical parameters include lab results, medications, prescriptions, previous outpatient visits, emergency visits, current ambulatory outpatient visits, quality of notes, long term benefits, time efficiency, and diagnoses. The benefits associated include quality of care, effect of patients, cost savings to physicians, error reduction, and organizational efficiency and regulatory compliance. Two parallel dimensional matrices were created in which one highlighted the positive aspects of HIE and the other highlighted the negative aspects.

The studies were then classified based on the nature of the article, and the material covered. We first divided each study into either a qualitative or quantitative study. Quantitative studies include any study formatted as a hypothesis testing study, cross sectional study, or predictive analysis. All classification schemes and syntheses were developed internally.

We then abstracted the relevant data from the articles using narrative synthesis. In synthesizing the articles, we reviewed the nature of the article, and the nature of the HIE discussed. We identified studies on mostly generalist based systems, emergency system only systems, and rarely specialty based systems. We found significant overlap amongst the many articles. While most qualitative, and some quantitative, studies reviewed the entire HIE system, some focused on a particular aspect. We noted what aspect was highlighted in the study accordingly. Many HIE range in geographic and demographic scope. Those exchange centers that were studied within a limited context were distinguished from those that encompassed all patients within the HIE.

Since few of the studies were quantitative in nature, it became difficult to analyze them through a standard meta-analysis. We abstracted details in select studies and identified themes within each publication. The themes formed the basis of the value-added graph allowing the concepts from each publication to organically flow into the two dimensional table.

There are no funding sources to disclose at any point in our data collection.

## **RESULTS**

Of the nearly 350 studies reviewed, we included 135 studies. The relatively high rate of inclusion is largely due to the

nature of the review and the assistance of established review studies that guided our literature review. Inclusion criteria included a specific mentioning of HIE and RHIO, or the transition of EHR and EMR to HIE. Further inclusion criteria includes any mentioning of HIE research, applicability, prominent obstacles, or inherent limitations. Of the studies compiled that met all the inclusion criteria 18% (24/135) were quantitative in nature. Of the study methods, 7% (10/135) only primary surveys, 28% (38/135) were editorial in nature, 47% (64/135) were informational in nature, 2% (3/135) conducted interviews, and 10% (14/135) were review articles. One study ran a simulation, and another study exemplified various business models applicable to a HIE. The majority claimed to be broad in scope and to represent that typical patient community. In our study, we find that 73% (98/135) maintain a broad scope. The remaining studies either specified a geographic scope or a particular clinical focus.

We did not distinguish between open and closed exchange systems since most new models considering adopting HIE are open models. However, for certain cases, such as emergency departments, we included only community based studies, therefore accepting only open based systems. This arrangement better suited our study's focus in developing generalizations for sustainable competitive advantage. Of the studies that met the inclusion criteria, 21% (28/135) focused on primary operations of an HIE, 3% (4/135) exclusively on emergency departments in community hospitals, 2% (2/135) on the financial aspects of HIE, 5% (6/135) on only patient safety and privacy, 2% (2/135) on HIV patient safety, 3% (3/135) on long term continuity of care, 11% (15/135) on the transition between electronic records and a viable exchange model, 4% (6/135) on improving adoption rates among hospitals, 3% (4/135) on utilizing standardizations, 4% (5/135) on improving cost effectiveness of HIE, and 2% (3/135) on developing a national scale model.

After cataloguing our studies, we integrated each study into our value-added table.

Figure 1

Table 1

Positive	Lab Results	Medications	Presoriptions	Previous and Repeat Visits to other Physicians	Emergency Visits	Ambulatory Visits	Quality of Overall Notes	Long Term Benefits	Time Efficiency	Dagnosis
Quality of Care	Information from other institutions on prior lab sects are at recurrent lesis and reas set ter use of extering lab results	medication facts, to reduce duplicates, reduce	More than 78 percent of surveyed of the that open orbing solidors arrefuled them to deliver better quality over	Interconnector by route make reportingon visits and certain infestions more efficient and complete	Emergency departments have allow percentage of patient health information available during attraction, and an even boson percentage of physicians who access it.	Increases achievence to guideline or protocol- besed core	Cue territorial temptates and specific studional use focus increasing efficiencies and implementation from physicians	Surveyed on a united as editing to pay extra to manage free teacher date, and to switch switch health of physicians to gains uch oppositions.	Physicians surveyed at operational Hill sene able to leave for the dyser for safesyl sacritising patient cere	State Funds HE program record the pall earth. Codes and published at terrestration of tecords for physicians
Effect on Patients	Instituty existenceded, interpretating data to theare non HSII, the cost is enings conversable in meaningful gain for pages to	Patients receive reutiple reminders of that patient intornation, and medication history and refills checkle.	Interoperable computational ordering systems increase the number of generic presorbtions	Patients solidat more confidence that all the medical his tory will be retained and reviewed	HE reduce has platfords in and "bourses back" dayes of te- has platfords	Surveyed patients that HE technology to provide prior medical information.	Patients on average prefer that prior notes and medical assessments are included in current medical notes	At institutions with HEE, and of life care man director time, and advanced director to, all increased	HEE partients surveyed are the style run or online core ultation at high rates	Patients prefer not horizing-net medical resort & an detering the responsibility to trust medical sources.
Cost Saving to Physician	Pully steel area, interpretable Hill, a new standardsed, reduce administrative costs to ophysician practices	HE note direct economic advantage to management brougherur reduction	Per amun, significant cost savings will come foun reductions in ambulating appealing drug error	Readily available prior data results in costs avings law ethnore on the ordert of HIE then patient limitations	Minor reductions in the number of emergency record in mejor mandiffy savings to the local health system.	One Hill estimates it will reduce health cere costs by outing costs associated with postage, staff time, and paper	More complete and detailed notes nealesses the physicians' risk of billing arrar	Hilli can rectude the need for administrative divertised requiring lies o employees and annithery staff	More efficient physicians carrindler focus on seeing more patients or on before patient management	Suit-iners methers in reduce ma diagnose from physicien
Error Reduction	Operational HEEs unyed observational number of resturble of resturb	Operational HIEs unyed site a batter error recognition mechanism and a reduced number of medication ervers	Operational HE survived obtain bulber in which recognition machinism and employed number of pres oription emers	HE computed reminders increased the prevalence of errors increasing patient retartion	providing providing	Malprazios insurance socita are louer among institutions implementing HEI as a source of partient information	The president of either motes, even repeat notes, either physicians to access data and patient file tonica	Adverse reaction of detection and reporting capability result in a reduction of inpatient enon, and better follow-up	Per annum, a reduced number of serios reduces the requisite serios operation of an indicate of a	Hill attact specific CC dedes to a given diagnos es regardies a schaffre it o written in to or as an acronym
Organizational Efficiency and Regulatory Compliance	Hill protocol is designed in adher enal with the health institution and all orders will tollo recist ing protocol	Safetyand complance is top-gaps to profession to the enthus medications are ordered and have conflicting medications are avoided	Pres original number including regulated substances are all regulated on Hill per health inclusion	Disease outbrails, and reporting of they disease and conditions, all improve through better regulation of HIE	Required reporting, end data retries all per pat lent selfety ensure less physician practice	Readly available data orests more efficient patient visits and avoid emirres as followup visits	Medical notes, without per standard of health institution, emure standardization order to ease data netrieval and sitting	Wide predicts of Hill results in sociation of Hill results in sociation of the second conditions or ordification of more tare conditions, and before results and predictions.	More efficient HE create more efficient physician- pat test practices allowing instructors to reduce the size of regulatory de partirisario.	HE develoned to the process of the p

Figure 2

Table 2

Negative	Lab Results	Medications	Prescriptions	Previous and Repeat Visits to other Physicians	Emergency Visits	Ambulatory Visits	Quality of Overall Notes	Long Term Benefits	Time Efficiency	Diagnosis
Quality of Care	True benefits from imagrating HE latinesults are notiume dependent and still require socur are data a titly	Medication date on HS are subject to input error stamming from other parts of information recorded	Adverse drug events that are truly preventable are ree and need high volume studies a ver- long horizone	Limitations in HE, or obseed loop HE requires to patient to frequent certain health institutions a style order to reap any benefits	Many emergency physicians rely force or presenting symptoms in order to begin initial management, some than existing patient data	Redundent noise in patient charts limit benefits obtained from additional access to patient records	Physicians believe that a patient nametive is more affective than a checkfird in semmunicatin g patient care	Physicians and previous four that a significant dependence on HE will affect provident incentive to save for patients and create undesired effects.	The bunder of implementation precludes real time efficiencies to be gained until years after an implementation	The utility of HE in diagnostics strybetness large providers and smaller providers with the latter seeing since no benefits.
Effect on Patients	Lab results that affect parties of sections are shearly that do established parties HE tanky Impro se upon	Oue to many challenges in a seroo ming institution wide HIE, many medication order systems semain off-systems of an HIE	Mest sheek systems that an HE will institute are sheety in place through the imescions of the physician and pharmacist	The need for an ideal patient identifier, and of consistency within that, presents to an Hill against o vercharing	Geographic acope, and restrictions in petient violas, affect the unefulness of HIE	The transition of parlient data from the in- parlient sector is self-inferred in a self-i	Physicians of the ignore all the charts available in an HE due to information o refeat resulting in the same charting qualityes if there use no HE	If physicians do not use HE so directed the benefits may become magnatized to the same is well prior to an HE	Time efficiency once accounting for learning the new technology and registering patient into mation, becomes less significant	The size of an institution, the accuracy of data input, and the confliction of multiple gartient identifies are constant issues HE do not address.
Cost Saving to Physician	The calculated net savings imply a high roturns of patients and a relatively consistent patient populations, which often is no time.	Placing medication orders between suited for the petient requires an equally competent soils system to execute the order property.	Efficient precipion allocation receives the settent to be fully educated on how to use the medications and when to re-	Physicians maybe neutrant to buyinto the concept of an HE because they had soon and in the contribute of the insurance side of each contribute.	Physician grate self to ousset more on the presenting condition than existing data, and true HE benefits occurs onlywhen physicians need further data	implementatio n result in high costs of replacing or	Patient notes are often lower in quality due to excess noise and template alternatives are not preferred by physicians	The value of developing and deploying a HE depends on the impact on patient in angement resulting from the data on flection, which can be sparse.	burden is onemus and results in precement	HE are limited by the same factors as existing electronic dutationes and make sapid, costilization of them to the same shown
Error Reduction	Hill propose to increase afficie noise by from the both improving the timing and reducing the number of tests required, this works better with a more he me geneva on putation in particular on the timing province.	Orders for less commonly used, or more rare, medications are the greatest source of error, but talks interview the lesst upon.	The greatest error reduction in HE often is marginally greater than the soluting electron is system.	Despite the increased distribution of medical necessarial properties on the same amission is propertied from up multiple visits.	The need for additional data occurs in onlys few patients and studies are ambiguous about the true error rate	HE without eliminate the existing encountraction of the countraction regions are not the comparison of	Notes reduction reduction reduction requirity and likelihood that physicians will use older charts	The benefits are shonger, the shonger the time horizon, between, few studies have seated to quantify the benefits to that extent	There is little to allow a streng co-relation between the two factors	M out physicians prefer to use HE for information gethering cather than data interpretation hence cases are a limiter with or without HE
Organizational Efficiency and Regulatory Compliance	ATHE maintain the same level of compliance as existing age to maintain and age to the compliance as existing age to the compliance as existing age to the compliance and the compliance are the compliance	While patient compliance horeases with HE, the rate of abuse, mis- ordaring, or inefficient refling has not been studied	ASHE maintain the same level of comprise or as existing pharmacourtic at ordering systems.	There is significant emblguity among many state and federal or spanitation for regarding the details on how patient information will be transferred.	Manyof the soleting models to tue only on a name geographic often in large urban areas, the petition on the form a seat patient population population.	Regulatory objects on soleting HE in this setting of the find numerous perfect sendentially violations	Physicians are overall wranythat data collection with provide genutre improvement in quality of one and regulatory overaght	In consistent HE standards byregulatory sependes reine sences that these agencies are not co maintaint or exproprietely preseriptive in promoting technical standards	this assumed that the greater the regulatory or except, the most time constraints will place through no study on rebordes this	Greater sight and covera light to make efficient diagnostic use, but it is unclear whether that offects management or how physiciams of coverable clients and coverable clients

#### DISCUSSION

Our table suggests that the context by which we gauge each clinical parameter determines the net benefit or downside. The benefits reaped from organizing emergency visits through an electronic exchange quickly fade when viewed from the perspective of the physicians themselves. The potential benefit of recording infection rates nationally become markedly more pronounced as the marginal size of the exchange system decreases. The intricacies of geographic scope of scale add another dimension that further complicates understanding all of the benefits. While certain articles note clear benefits in more closed, homogenous patient populations, it is not clear how those benefits translate to larger health institutions. This is not to say that large clinics do not contain unique benefits in and of themselves. The established literature and prior studies attest to the unique benefits of each system. In our tables, we attempt to capitalize on the general principles that construe benefits and downsides in each clinical parameter per the vantage point of the clinicians.

Since our goal is to determine what principles can be generalized to all HIE inclusive of size, scale or scope, our contribution lies in identifying the clinical parameters in parallel. This discrete format demonstrates that no one parameter can be ubiquitously assigned as a benefit or downside.

Our value-added proposition implies we turn towards a more nuanced understanding of an HIE's competitive advantage. A sustainable competitive advantage is the ability to provide a service to the target consumer in a manner that an alternative option cannot. To identify true benefits, one must determine what additional benefits an HIE would provide within a specific context. For instance, will the target consumer be government organizations instituting a system that hospital systems buy into? Or will the target consumer be smaller practice groups that are sought after by larger academic or insurance based systems? These questions affect the scope and viability of HIE.

While many of the benefits of HIE can be countered with legitimate uncertainties, one should not discount the burgeoning potential of these systems. Disruptive innovations, which HIE's propose to become in today's healthcare, have the ability to convert seemingly low value solutions into viable options that become the optimal path. In a field such as information technology exchange, network externalities play an immense role in creating consumer

awareness and increasing the value of the technology. Many uncertainties are influenced by the physician's willingness to adopt or accept the role of HIE. Increased implementation by physicians will have a positive exponential effect and mitigate such uncertainties.

Research into the field should be inventive and bold. With such a complex concept involving innumerable variables, it is not likely to be solved without many prior attempts. Beyond finding an optimal operational model for HIE, experimentation will identify why concepts have not worked in the past.

Limitations in this study include the methods of collection to the overall analysis, and the data abstraction. We were unable to perform a meta-analysis of the available literature because few of them were quantitative in nature. Further majority of the studies pertaining to this topic are subject to journalistic bias. The authors, predominantly leaders in the field, have certain perspectives on how an exchange system should run. Abstracting a narrative synthesis from their vantage point provides only a portion of the functionality relating to HIE.

Additionally, our search was limited to the strength of the terminology we used for our literature search. Key terms such as "Health Information Exchange" may not adequately encompass all the literature available on the subject. We avoided this error in part by cross referencing our literature review with established literature searches to ensure comprehensiveness. However, those journal articles referencing HIE with unique terminology or case specific phrases are likely to have been missed. We also limited our search to English-based studies and included only a limited number of unique search engines to further our literature review.

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