

# The Impact of Health Information Exchange on Health Outcomes

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## Keywords

Medical record linkage, health services, health utilization, review literature, health information exchanges

## Summary

**Background and Objective:** Healthcare professionals, industry and policy makers have identified Health Information Exchange (HIE) as a solution to improve patient safety and overall quality of care. The potential benefits of HIE on healthcare have fostered its implementation and adoption in the United States. However, there is a dearth of publications that demonstrate HIE effectiveness. The purpose of this review was to identify and describe evidence of HIE impact on healthcare outcomes.

**Methods:** A database search was conducted. The inclusion criteria included original investigations in English that focused on a HIE outcome evaluation. Two independent investigators reviewed the articles. A qualitative coding approach was used to analyze the data.

**Results:** Out of 207 abstracts retrieved, five articles met the inclusion criteria. Of these, 3 were randomized controlled trials, 1 involved retrospective review of data, and 1 was a prospective study. We found that HIE benefits on healthcare outcomes are still sparsely evaluated, and that among the measurements used to evaluate HIE healthcare utilization is the most widely used.

**Conclusions:** Outcomes evaluation is required to give healthcare providers and policy-makers evidence to incorporate in decision-making processes. This review showed a dearth of HIE outcomes data in the published peer reviewed literature so more research in this area is needed. Future HIE evaluations with different levels of interoperability should incorporate a framework that allows a detailed examination of HIE outcomes that are likely to positively affect care.

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## 1. Introduction

Health Information Exchange (HIE) refers to the sharing of clinical and administrative data across the boundaries of health care institutions, data repositories, and groups (payers, patients, providers, and others) according to nationally recognized standards [1, 2]. The importance of HIE has been the focus of several national agencies interest including the Department of Health and Human Services (DHHS) due to the potential for HIE to positively impact health care quality; in March 2010, DHHS awarded \$162 million to stimulate HIE use in 16 states [3].

The potential benefits attributable to HIE include improved quality of care, efficiency, and patient safety, facilitated communications among providers, improved public health surveillance, facilitated quality of care measurement such as the ability of an organization to identify infectious disease outbreaks and decreased health care costs [4]. However, research on HIE clinical outcomes remains sparse; a systematic review of the effects of health information technology on quality, efficiency, and costs of health care included 257 articles but none of them involved HIE as it is now defined [4].

Much has been written on HIE implementation and adoption showing that there is still a need of extensive HIE effectiveness demonstration to leverage its use [2, 5–13]. Current or future HIE initiatives should use evidence-based information to make decisions about planning, implementation and operation of HIE's as well as prioritize research and funding. The purpose of this review is to identify and describe evidence of HIE impact on health outcomes and health care costs.

## 2. Methods

We conducted a literature review to identify English-language investigations describing HIE outcome evaluations by searching articles listed in the MEDLINE and, Academic Search Premier databases between January 1995 and December 2010. We defined outcomes as any change in patients' health status or health services utilization. The two authors reviewed articles for inclusion independently. Open discussions were held to solve disagreements, until consensus was reached. We adopted a broad definition of HIE to include any study where electronic data sharing occurred between different healthcare settings. The search combined the terms health information exchange, information exchange, electronic health information exchange, electronic data interchange, sharing medical information, and outcomes assessment (MESH). Articles were included if they were original investigations in English that focused on HIE outcomes. Articles were excluded if they related to HIE in health care consultation (i.e., patient-provider communication) or addressed evaluation of health information technologies other than information exchange (e.g., electronic health records, personal health records, electronic prescribing, computerized physician order entry). HIE policy discussions, implementation concerns, technical architecture reports, economic models, and theory building case studies were also excluded. A qualitative coding approach was used to analyze the data. Qualitative coding consists in the creation of thematic categories, and the establishment of the relationships between categories [14].

## 3. Results

A total of 207 abstracts were retrieved and reviewed by the two authors. Initially, 20 articles met the inclusion criteria. After the evaluation of the 20 initial articles reference lists, we identified three additional articles. Eighteen articles were excluded during a second review cycle because the articles were inaccessible ( $n = 4$ ) or did not perform outcome assessment but instead investigated participants' perceptions of HIE potential outcomes ( $n = 14$ ). A total of 5 articles met the inclusion criteria. Of these, 3 were randomized controlled trials, 1 involved retrospective review of data, and 1 was a prospective study (Table 1).

### 3.1 Health Care Utilization

One study evaluated the effect of increased access to patient clinical information in the hospital setting [15]. In this study, computer-based patient data from one urban hospital were shared electronically with the emergency physicians at two other urban hospitals. The researchers randomized 32,468 patients to either the control or intervention group. In the intervention group, ED physicians could access an online system containing clinical information for a patient who was seen at one of the study hospitals. The clinical information included: inpatient laboratory results; discharge summaries; operative reports; ED visit notes; diagnostic tests; dictated clinical notes; and medication history. ED physicians in the control group did not have access to these patient-specific data. For the primary outcome, the investigators collected data from each hospital's billing records measuring the mean ED charge for a single encounter and the first day's charges for each patient if admitted to the hospital. The first day's charges were included because Medicare requires that hospitals combine ED and inpatient charges in one bill for patients admitted to the hospital; the investigators were unable to split these charges. The intervention group in only one hospital showed a statistically significant decrease in ED charges (\$26.52 cost savings  $p = 0.037$  vs. \$25.36  $p = 0.073$ ). However, researchers could not identify where the savings originated (e.g., radiology, laboratory, facility, or pharmacy charges). This study established the feasibility of exchanging clinical information data between institutions for emergency care, but did not demonstrate conclusive cost reductions.

In another study, Lang et al. evaluated a web-based standardized communication system that enabled family physicians in Canada to receive patient reports from ED visits [16]. This study, which was an unblinded 4-period crossover cluster randomized controlled trial, assessed the number of repeated visits to the ED and health services utilization at family physician office. During the intervention period, family physicians received patients' detailed information such as laboratory tests results, and medication history, for each participant's visit to ED through an electronic system 24 hours after the visit occurred; while in the control phase family physicians received by mail a paper copy of the first page of the ED's discharge notes. To measure resource utilization, the investigators used the hospital's database and asked family physicians to self-report the number of health services required at each visit.

The results of this study are mixed. Although researchers found that system decreased the ED return visits after 28 days for all patients older than 65 years old (OR = 0.70; 95% CI, 0.49 to 1.0), there was a significant increase in specialty consultation requests for the intervention (20 vs. 8  $p = 0.049$ ). The study did not find a statistically significant reduction in the number of repeated ED visits after 14 day of the initial visit (OR = 1.1; 95% CI, 0.8 to 1.51) or in any other measure of health services utilization.

Hansagi et al. conducted a randomized controlled trial to evaluate the usefulness of sharing clinical information between ED's and primary care clinics in one Swedish hospital over a 24-month period [20]. The hospital's electronic database identified those who were frequent users of the ED (>3 visits per year) in the previous 12 months. These patients were then randomized into an intervention group ( $n = 834$ ) or a control group ( $n = 965$ ). Hard copy information about the patient's last three ED visits was forwarded by the study staff to ED physicians ( $n = 57$ ) and primary care physicians ( $n = 37$ ) for the intervention group via an unspecified method during the following 12 months. The investigators assessed health care utilization by examining the mean number of ED visits, mean number of primary care physician visits, mean number of specialist outpatient clinic physician visits and mean number of days in the hospital by collecting data from the hospital database system. Investigators analyzed differences in means before and after the intervention for both groups and administered a survey to evaluate ED and primary care physicians' perceptions of the value of easy access to patient medical information. This study failed to show significant differences between the control and the intervention group during the 12 month of prospective data collection for any of the health care utilization outcomes analyzed. However, the researchers reported that 82% of ED physicians and 76% of primary care providers perceived the information obtained through the exchange as useful.

Vest J, tested the hypotheses that access to an HIE would be associated with lower rates of inpatient hospitalizations or emergency room utilization for sensitive ambulatory care conditions such as asthma, diabetes, ear infections, or pelvic inflammatory disease [18]. The investigator retrospectively

analyzed data from the Integrated Care Collaboration (ICC) of Central Texas data repository. The ICC is a centralized database containing clinical information added by eighteen organizations including hospitals systems, clinics, and governmental agencies. These organizations can access data in the repository through a secure website. This study analyzed data for 6,114 patients between 2005 and 2007. The researcher created information access index using the information logs to measure the HIE utilization. The results of this analysis indicated that HIE was associated with increased health care utilization. HIE information access was significantly associated with higher emergency room visits (OR = 1.96; 95%CI 1.70 to 2.26), clinic visits (OR = 1.63; 95%CI 1.46 to 1.82), and hospital admissions (OR = 2.02; 95%CI 1.38 to 2.98). In addition, the higher the level of HIE information access the higher the probability of emergency room visits and ambulatory care sensitive hospitalizations. The author proposes as possible explanations for the study results: the inadequate or inefficient use of the HIE, unavailable data or missed data by the users, or that the information was not accessed by whom it would be most beneficial. Finally, the higher use of health services utilization associated with sicker patients could have driven HIE use.

### 3.2 Health Outcomes

Using a quasi-experimental study design, Branger et al. assessed the outcomes of an information exchange between 32 general practitioners and an internal medicine consultant who provided care to 275 diabetic patients in The Netherlands [19]. Researchers compared traditional paper-based reporting process to an electronic system for data exchange. The system allowed hospitals from the Apeldoorn area to exchange admission summaries, discharge reports and laboratory test results. When a general practitioner referred a patient, an electronic message containing the patient demographic information, reporting dates, and information from the electronic medical record was generated. Before the message was transmitted to the other provider, the referring physician was able to edit the message, add free text or discard data. The researchers selected the 20 practitioners with the highest number of patient referrals to form the intervention group; this group received the exchange communication module. The remaining 12 general practitioners were designated as the control group and continued working without the inter-physician communication module. This investigation showed that the mean difference of HbA<sub>1c</sub> levels of patients of intervention group decreased compared to the levels measured before the intervention (from 7.0 to 6.8 p = 0.03). The control group's patients did not demonstrate a significant decrease in the HbA<sub>1c</sub> levels (from 6.6 to 6.5 p = 0.52). The mean differences of HbA<sub>1c</sub> levels in the intervention group's patients were not significantly different than the control group's patients (0.21 vs 0.12 p = 0.68) (► Table 1)

## 4. Discussion

The main objective of this study was to present a review of relevant published literature about the effect of HIEs on health outcomes. Although the HIE definition used in this review was broad and may not meet the requirements of current HIE definitions, we found little research that aimed at evaluating the impact of HIE on patients' health and health care utilization outcomes. Moreover, the few articles that met our inclusion criteria varied significantly in methodology and different measures were used for outcome assessments. The majority of the outcomes measures focused on health care utilization such as number of visits to ED and duplication of services and costs. Only one of the three randomized controlled studies included in this review identified positive HIE outcomes. Overhage et al. found significant cost savings (\$26.52) in ED charges per visit at one of the two hospitals involved. In comparison, Lang et al. did not find differences in the number of repeated visits to ED two weeks after the initial visit; Hansagi did not find findings favoring HIE in any of the outcomes measured. Moreover, in Vest et al.'s retrospective analysis, HIE use was associated with greater health-care services utilization.

There may be several reasons for the lack of results supporting HIE services. The study intervention periods were relatively short, varying from 6 to 30 months, which could prevent long-term benefits to become evident. Also, all studies aggregated costs and other utilization measures for analyzing data. Therefore results may be confounded by factors such as illness severity. In addition, ag-

gregation of data per patients' visit may impede evaluating the impact of HIE on repeated number of laboratory tests and x-rays. These outcomes should be further explored separately. There is a need for the development and validation of measures to evaluate HIE effectiveness. These measures should account for the different levels of interoperability that can be achieved with HIE [21]. The majority of studies reviewed focused on number of repeated emergency or primary care visits as outcome measure, which do not necessarily reflect the potential for HIE effectiveness in its entirety. For example, the impact of HIE on medication reconciliation and thus medication safety could be additionally examined.

None of the investigations directly addressed training of HIE users, which could have resulted in systems' under-utilization and reduced power. In addition, the behavior of consulting HIE only when others sources have been exhausted can negatively impact HIE potential benefits [22, 23].

Several literature reviews have been conducted on health information technology (HIT) [24–28]. However, these reviews do not focus on HIE and include a wide range of technologies such as computerized physician order entry, electronic health records, or computerized decision support. Chaudry et al. included data exchange networks in their systematic review; however they did not find an improvement in health outcomes for HIEs [24]. Additionally, other published HIE reviews concentrate on systems capabilities, implementation approaches, or costs and have found that HIE initiatives are diverse impeding the selection of a preferred strategy for evaluation [29]. HIE effects on health care are the consequences of the connectivity between hardware, software, and different stakeholders such as providers, patients and payers. This complex interrelationship between system components may prove to be a challenge for HIE outcomes evaluation [30]. In addition, the gradual implementation and adoption of technologies such as HIE may prove to be an impediment to the identification of a point to make to pre-post comparisons [31]. While it may at first seem that this review produces evidence against HIEs, this is not the case. The intent of this article is to point out that additional well-designed studies of the outcomes of HIEs are desperately needed. It is our hope that researchers will find this an interesting area for study and develop effective measurement tools, study patient outcomes and publish these results.

This review has several limitations. We identified a very limited number of articles that met our study criteria and therefore general conclusions cannot be drawn from this review. In addition, HIE initiatives in the early stages of operation and their outcomes evaluations may not appear in publication yet or may not be available via peer-reviewed journals. The limited sample size and low power of the studies reviewed prevent us to draw definite conclusions of HIE effectiveness.

## 5. Conclusion

Outcomes evaluation is required to give healthcare providers and policy-makers evidence to incorporate in decision-making processes. This review showed a dearth of HIE outcomes data in the published peer reviewed literature so more research in this area is needed. Future HIE evaluations with different levels of interoperability should incorporate a framework that allows a detailed examination of HIE outcomes that are likely to positively affect care.

### Conflict of interest

The authors declare that they have no conflicts of interest in the research. This study was funded by the Centers for Medicare and Medicaid (CMS) Grant Number 0705AZTRA1 provided to Arizona for the Medicaid Health Information Exchange and Utility Project.

### Protection of Human and Animal Subject

The article did not involve research on human subjects.

**Table 1** Description of original investigations evaluation HIE outcomes

| Author/<br>Year of<br>publication | Setting      | Research<br>design  | Sample size<br>(N)                   | Comparison  | Participants<br>in the ex-<br>change | Data Exchanged   | Primary Outcome   | Main Findings  | HIE Find-<br>ing<br>Summary |
|-----------------------------------|--------------|---|--------------------------------------|---|--------------------------------------|--|---|--|-----------------------------|
| Overhage et al. 2002 [15]         | Multi-centre | Randomized controlled trial (at patient level)                    | 32,468 patients                      | Electronically delivered patient information<br>Vs.<br>No patient information delivered electronically                                      | ED physicians                        | Diagnosis, laboratory tests and electrocardiogram results, imaging reports, medication therapy, ED visit reports, and clinic visit reports | Mean ED charges for a single encounter  | Cost savings \$26.52 p = 0.03 per ED encounter at 1 of the 2 participant hospitals in the intervention group | +                           |
| Lang et al. 2006 [16]             | Single site  | Crossover cluster randomized controlled trial (at provider level) | 2,022 patient visits<br>23 providers | Web-based standardized communication system<br>Vs.<br>One-page print-based reports sent by mail   | Family and ED physicians             | ED visit reports, diagnosis, laboratory tests and electrocardiogram results, imaging reports, and medication therapy                       | Repeated visits to the ED within 14 days of the initial visit   | No significant difference between intervention and control group   | -                           |
| Hansagi et al. 2008 [20]          | Multi-centre | Randomized controlled trial (at patient level)                    | 1,799 patients                       | Patients' ED information for frequent users forwarded by the study staff to PC and ED physicians<br>Vs.<br>No patient information exchanged | PC and ED physicians                 | Data exchanged not described by authors  | Mean # of ED visits, mean # of PC physician visits, mean # of visits to specialist outpatient clinic physician and mean # of days in hospital | No significant difference between intervention and control group   | -                           |

ED= Emergency Department, PC= Primary Care AUD=Australian Dollars

Table 1 Continued

| Author/<br>Year of<br>publication | Setting          | Research<br>design                     | Sample size<br>(N) | Comparison  | Participants<br>in the ex-<br>change  | Data Exchanged   | Primary Outcome  | Main Findings   | HIE Find-<br>ing<br>Summary |
|-----------------------------------|------------------|--|--------------------|---|---|--|--|---|-----------------------------|
| Vest J.<br>2009 [18]              | Multi-<br>centre | Retrospective<br>database<br>analysis  | 6,114 patients     | Index of HIE use: zero<br>(none), low (1 view),<br>medium (2–3 views) or<br>high (4 or more views<br>during three years). | Members of the<br>Integrated Care<br>Collaboration<br>(ICC) of Central<br>Texas | Demographic and<br>clinical data except<br>encounters covered<br>by Medicare | Inpatient<br>hospitalizations<br>Emergency room<br>utilization   | Any level of HIE access<br>was associated with a<br>higher frequency of ED<br>visits (OR = 1.96;<br>95%CI 1.70 to 2.26),<br>clinic visits (OR = 1.63;<br>95%CI 1.46 to 1.82), and<br>hospital admissions (OR =<br>2.02; 95%CI 1.38 to 2.98) | -                           |
| Branger et al.<br>1999 [19]       | Multi-<br>centre | Prospective<br>quasi-experi-<br>mental | 275 patients       | Paper-based communi-<br>cation<br>Vs.<br>Electronic communication   | General Practi-<br>tioners<br>Internal medi-<br>cine providers                  | Administrative data<br>Medical data  | HBA1c levels and the<br>frequency of com-<br>munication between<br>general practitioners<br>and internal medi-<br>cine providers | Mean differences in<br>HBA1c level reduction in<br>the intervention group vs.<br>the controls were not sig-<br>nificant (0.21 vs. 0.12 p =<br>0.68).  | -                           |

ED= Emergency Department, PC= Primary Care AUD= Australian Dollars

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