

“Hidden” Value: How Indirect Benefits of Health Information Exchange Further Promote Sustainability

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Background: Health information exchanges (HIEs) have already demonstrated direct value in controlling the costs associated with utilization of emergency department services and with inpatient admissions from the emergency department. HIEs may also affect inpatient admissions originating from outside of the emergency department.

Objective: To assess if a potential association exists between a community-based HIE being used in hospital emergency departments and inpatient admissions emanating from outside of the emergency department.

Methods: The study design was observational, with an eligible population of fully insured plan members who sought emergency department care on at least 2 occasions over the study period between December 2008 and March 2010. Utilization data, obtained from medical and pharmacy claims, were matched to a list of emergency department utilizing where HIE querying could have occurred. Of the eligible members, 1482 underwent propensity score matching to create two 325-member groups—(1) a test group in which the HIE database was queried for all members in all of their emergency department visits, and (2) a control group in which the HIE database was not queried for any of the members in any emergency department visit.

Results: A post–propensity matching analysis showed that although the test group had more admissions per 1000 members overall (199 more admissions per 1000 members) than the control group, these admissions might have been more appropriate for inpatient treatment in general. The relative risk of an admission by the time of a first emergency department visit was 28% higher in the control group than the test group, although by the time of a second emergency department visit, it was only 8% lower in the control group. Moreover, test group admissions resulted in less time spent as inpatients, which was denoted by bed days per 1000 members (771 fewer bed days per 1000 members) and by average length of stay (4.27 days per admission for all admissions and 0.95 days per admission when catastrophic cases were removed).

Conclusions: Based on these results, HIE availability in the care of patients presenting to the emergency department is associated with fewer inpatient hospital days and a shorter length of stay, even when catastrophic cases are removed from the analysis. Although many factors can play a role in this finding, it is possible that HIE promotion of more appropriate hospital admissions from outside of the emergency department is one cause. Such “indirect” value shows that the return on investment found by HIEs may even be greater than previously calculated. Additional study is warranted to further the business case for HIE investment for the various stakeholders who are interested in supporting HIE sustainability.

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KEY POINTS

- Health information exchanges (HIEs) have shown direct value in controlling costs related to emergency department utilization and inpatient admissions from the emergency department.
- The costs associated with inpatient admissions, which account for the majority of healthcare dollars spent, are on the rise; 44% of all hospital admissions originate in the emergency department.
- Two previous studies have shown average savings ranging from $26 to $29 for HIE use in the emergency department; a third study showed a decrease in hospital admissions from the emergency department as well.
- The current study shows that making HIE available for patients in the emergency department reduces the length of hospital stays for admissions not tied to emergency department services.
- The noted decreased length of stay, even when catastrophic cases are removed from the analysis, suggests that the availability of HIEs in the emergency department reduces inpatient utilization emanating from outside of the emergency department.
- These findings further support that incorporating the use of HIEs in the emergency department can reduce overall hospital admissions rates, lower the length of hospital stay, and, therefore, decrease the associated costs.

of care, and the ultimate goal of an overall decreased cost of care.

More recently, we have witnessed a seismic movement from theory to practice with definitive dollar savings noted for HIE use in emergency departments in Indianapolis, IN, and in Milwaukee, WI ($26 and $29 savings per emergency department visit, respectively), as well as in Memphis, TN (approximately net $1.1 million in savings for the community at large). Moreover, in Memphis, the great majority of dollar savings (97.6%) resulted from the avoidance of inpatient admissions from the emergency department. Inpatient admissions account for the preponderance of dollars spent in healthcare. Costs for inpatient admissions in the United States are increasing; during calendar year 2004, the average inpatient admission cost was $10,030; by 2008, this increased to $15,017.

A community replicating the Memphis experience by mitigating inpatient admissions from the emergency department should experience financial savings as Memphis did. The Memphis experience showed that HIE availability within the emergency department decreases direct admissions from the emergency department. But can HIE availability in the emergency department indirectly impact admissions emanating from outside of the emergency department? Is the risk of any inpatient admission occurring altered by the presence of HIE in the emergency department? If so, the community benefits indirectly, as well as directly, from having said HIE occurs within the emergency department. However, achieving that benefit requires HIE sustainability, and HIE sustainability requires a stable source of funding.

Enhancing the business case for HIE sustainability by uncovering such indirect or “hidden” value may help validate the need for external support and funding.

Background

In our previous article promoting the “business case for payer support of a community-based HIE,” we described the relationship between Humana in Southeast Wisconsin and the local HIE. To briefly summarize, beginning in December 2008, Humana provided a financial incentive to the Wisconsin Health Information Exchange (WHIE) for promoting the querying of a database by emergency department clinicians (as a part of their workflow) for fully insured members presenting to the emergency department for care. WHIE links together disparate emergency departments across 5 competitive health systems in Milwaukee County.

Our previous evaluation showed a positive direct financial outcome for our health plan, with an average savings of $29 per emergency department visit when clinicians queried the WHIE in the course of providing emergency department care as opposed to when the WHIE was not queried. We also realized a direct return on investment (ROI) of more than 2:1. Further analysis looking at other potential sources of value, some of which may result from indirect savings, may help further the business case for external HIE support and may also show that the value of HIE may even be higher than what we can quantitatively measure.

Methods

Study Design: Developing the Sample

Population for Evaluation

The Humana version of an Institutional Review Board, the clinical “Stage Gate Process,” provided approval for this pilot assessing the impact of HIE query in the emergency department. The planned evaluation included both observational and retrospective analyses. In developing the member pool from which to draw the evaluation population, Humana and the WHIE had agreed that the plan would provide to the WHIE a financial incentive to cover its costs for promoting emergency department clinicians’ querying of the WHIE database.
Although queries apply to all patients, the incentive only covered eligible Humana members presenting to the emergency department for care. Eligible members were commercial, fully insured members only; self-funded group members, as well as members covered by governmental programs (eg, Medicare), were specifically excluded. Every quarter, WHIE provided Humana specific information about each individual health plan member who was fully insured by Humana and who sought emergency department care, as well as when the emergency department clinician accessed the WHIE database for that patient and at which facility. WHIE only provided clinical data as it would appear on a claim related to the encounter. All communications were HIPAA compliant and used encrypted files. The information that was provided allowed Humana to match emergency department claims data received from providers with the emergency department encounter by date of service and facility.

In working with claims data, we stipulated precise parameters for member inclusion in the evaluation sample. Inclusion criteria noted in the original analysis stipulated that:
1. All members included in the evaluation must have had at least 12 months of continuous coverage with our health plan
2. Members would be excluded from the evaluation if they had either less than 6 months of coverage before the start of the program or less than 3 months of coverage after the start of the program
3. Because admissions from the emergency department or prolonged emergency department holds of “24-hour observations” would have impaired our ability to perform the original analysis on emergency department costs, we excluded those members (admitted from or held in the emergency department) from the analysis.

These exclusions prevented potential skewing of the data for our analyses.

Study Design: Developing the Control Group and the Test Group

In our previous article, we discussed in great detail how we determined who would make up the control and test groups. Humana identified members seen in the emergency department when the WHIE database was queried in both a first emergency department visit and a subsequent emergency department visit as eligible to be included in the test group; members seen in the emergency department where the WHIE database was not queried in neither a first emergency department visit nor in a subsequent emergency department visit (because the facility had not yet provided WHIE access at that time) were eligible to be included in the control group. A total of 428 plan members were deemed eligible for the test group, whereas 1054 plan members met control group eligibility.

In addition, our evaluation deliberately assumed the need for propensity scoring, because that technique affords the best way to match members, while minimizing bias. Propensity scoring provides “the conditional probability of receiving the treatment given the observed covariates.” In their defining article, Rosenbaum and Rubin showed that “the adjustment for the scalar propensity score is sufficient to remove bias due to all observed covariates.” Furthermore, propensity scoring has been found to yield estimates that are not substantially different from typical multivariable methods.

For the logistic regression yielding the propensity scores, we used all of the following combinations of cost-related and demographic variables to match the 2 groups: age, sex, medical net paid per participant per month (PPPM), prescription net paid PPPM, medical plus prescription net paid PPPM, medical inpatient net paid PPPM, medical outpatient net paid PPPM, and medical physician net paid PPPM. With the exception of age and sex, all of these variables represent dollar values, because dollar values are easy to calculate from claims and they were unrelated to the specific exposure (ie, WHIE database querying).

Propensity scores on which we matched the participants used the nearest neighbor algorithm. Matching allows for “sampling from a large reservoir of potential controls to produce a control group of modest size in which the distribution of covariates is similar to the distribution in the treated group.” For member matching, MATLAB version 7.0.1.1 was used.

Data Analysis

Once we completed matching 325 pairs of individuals for the test and control groups, we analyzed differences in the metrics of interest for the 2 groups. For descriptive chi-square and other statistics, SAS Enterprise Guide version 4.2 was used. We compared all claims for the 2 groups for a time period beginning 1 year before an individual’s first emergency department visit date to an end date of 1 year after that first emergency department visit date; therefore, each individual’s length of time in the pilot was 1 full year.

The pilot ran from December 2008 through March 2010. Within that 1-year time period, a group member would still need to have a second emergency department visit before the end date. The emergency department visit served to delineate a point in time where we evaluated member utilization; in other words, we looked at the member’s inpatient utilization at the time of a first
emergency department visit and then again at the time of a second emergency department visit.

For this specific analysis, we looked at differences in inpatient admissions, inpatient days, and length of stay (LOS) to gauge a possible association for HIE impact outside of the emergency department. We used routine payer parameters to calculate differences in admissions per 1000 members, bed days per 1000 members, and in average LOS per admission at the times of a first and of a subsequent emergency department visit for the 2 populations of interest, with adjustment for trend between the 2 time periods.

Results

Descriptive results before and after propensity score matching for all eligible control population and test population members are shown in Table 1. Table 2 outlines inpatient admissions per 1000 members for the propensity-matched cohort, as well as for the summed population results at the time of a given emergency department visit and by group designation. A chi-square test for independence of the groupings and the time period of emergency department visit show that the admissions per 1000 members of each group are not independent of the time period when a member of the group was seen in the emergency department. This finding implies that inpatient admissions, unrelated to an emergency department visit, may be impacted by the use of HIEs within the emergency department.

Table 3 describes the conditional probabilities within the 2 groups; we specifically examined the probability of an admission during a specific time frame given the possible use of HIEs in an emergency department. The conditional probability results show that first, the probability for having had an admission in either group is more likely at the time of a second emergency department visit than at the time of a first visit (eg, 67.4% of all admissions studied occurred by the time of a second emergency department visit).

Second, the probability of having had an admission at the time of a first emergency department visit is greater in the control group (37% vs 29%, in favor of admission with no HIE query in the emergency department), whereas the probability of having had an admission at the time of a second emergency department visit is greater in the test group (71% vs 63%, in favor of admission with HIE query in the emergency depart-

<table>
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<tr>
<th>Table 1</th>
<th>Descriptive Results for All Study-Eligible Members, by Potential Group Assignment Prematching, and by Actual Group Assignment Post–Propensity Score Matching</th>
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<tbody>
<tr>
<td>Period</td>
<td>Prematching</td>
</tr>
<tr>
<td></td>
<td>Group participation eligibility</td>
</tr>
<tr>
<td>Time of first emergency department visit</td>
<td>Control</td>
</tr>
<tr>
<td>Time of second emergency department visit</td>
<td>Test</td>
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<table>
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<tr>
<th>Table 2</th>
<th>Comparison of Admissions per 1000 Members for Propensity-Matched Control and Test Groups</th>
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<tbody>
<tr>
<td>Period</td>
<td>Test group, N</td>
</tr>
<tr>
<td>Time of first emergency department visit</td>
<td>269</td>
</tr>
<tr>
<td>Time of second emergency department visit</td>
<td>664</td>
</tr>
<tr>
<td>Total population, by group</td>
<td>933</td>
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</tbody>
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Chi-square test for independence: $\chi^2 = 12.34$; since $P < 0.005$, the admissions per 1000 members for each group and the 2 time periods are not independent. Decrease in admissions per 1000 members for the test group between emergency department visits $= 269 \times (555/321) - 664 = 199$. |
ment). Another way of viewing these results is to note that the absolute risk of any inpatient admission by the time of a first emergency department visit is 8% higher (relative risk [RR], 28% higher) in the control group, whereas the absolute risk of any inpatient admission by the time of a second emergency department visit is 8% lower (RR, 11% lower) in the control group.

Table 4 and Table 5 show the results of the other standard payer metrics, inpatient bed days per 1000 members, and average LOS for the propensity-matched cohort, by time period of emergency department visit and by group designation. As seen in Tables 4 and 5, when accounting for trend, the availability of HIE in the emergency department may be associated with shorter LOSs for admissions emanating outside the emergency department (4.27 days per admission) and a decreased number of inpatient days in total (771 bed days per 1000 members).

However, the noted results, especially for the average LOS calculations, may be skewed by an abnormally high number of catastrophic cases, as noted by the maximum LOSs in Table 6. Addressing such discrepancies by removing all inpatient admissions with an LOS of at least 33 days, even without further adjusting for the propensity matches, generates the results outlined in Table 7. These results show that simply having HIE available in the emergency department may yield a potential savings in LOS of nearly 1 full day (0.95 days per admission).

**Discussion**

Approximately 44% of all hospital admissions, or 55% of hospital admissions excluding pregnancy and childbirth, use the emergency department as the conduit for entry. Conversely, 56% of all admissions (or 45% of all admissions, excluding pregnancy and childbirth) are not admitted through the emergency department. Such findings necessitate looking at methods to alleviate hospital admissions that do not originate from the emergency department. One way of doing this is to ensure appropriate admissions.
Review of our results show some promising findings. In our study, an emergency department visit by a member of the test group or the control group did not result in an admission from the emergency department. However, each group’s members had admissions from outside of the emergency department.

When we look at the likelihood of a first admission from outside of the emergency department by a group member, the results show a 28% higher probability of an admission when HIE is not available in the emergency department. Given that physician offices provide data for HIE in the emergency department, it is more likely that emergency departments with access to HIE have physicians with access to HIE. We could theorize that a lack of access to information at the point of care, especially if that point of care is outside of the emergency department, may provide the impetus for potentially inappropriate admissions.

In his study, Campbell previously noted that 28% of the hospital admissions deemed as “inappropriate” occurred secondary to a need for the performance of treatment or tests that could have been performed on an outpatient basis. Moreover, assumptions that appropriate admissions require longer LOSs do decrease what may be considered “inappropriate,” because admissions with shorter LOSs should not have been admitted at all. Multiple factors can play a role in potentially inappropriate admissions, including, but not limited to, difficulty in organizing continuity of care (eg, outpatient physician follow-up) versus receipt of community services (eg, home healthcare) or even rural geography. That members of the test group had more admissions at the time of a second emergency department visit could imply that the use of HIEs before then might have played a role in avoiding inappropriate admissions, thereby leading to more appropriate use of inpatient resources overall.

From our previous study, we were certainly aware that the test group “required higher intensity care on a claims dollar basis,” implying that they were “sicker” on the basis of claims. Conversely, because the control group had more inpatient admissions by the time of a first emergency department visit, we could surmise that a lack of connectivity factored in that finding as well. Could that result prolong hospital stays?

Our finding of a significant decrease in the bed days per 1000 members for the test group relative to the control group by the second emergency department visit makes us begin to question if there is a correlation of HIE availability with shorter hospital stays; in fact, the noted savings of 4.27 per admission seemed so extreme (because of several cases of at least 33 days per admission), that it necessitated removing 5 of 238 (2.1%) admissions from the test group and 14 of 231 (6.1%) admissions from the control group to better assess this premise. Despite removing catastrophic cases, we still found a decrease of nearly 1 full day per admission for the test group. Having HIE itself in the emergency department did not directly influence this finding, but it certainly could have acted indirectly.

Research has shown that indirect returns can account for 50% of a technology’s ROI. It is this ROI that is made meaningful by, in this case, decreasing inpatient services. ROI should certainly not be the only measure of the value that HIEs bring. HIEs can offer a clinical “value added” through providing services in a manner that an alternative cannot. In our case, the “service” provided may be the indirect promotion of more appropriate inpatient admissions, containment of inappropriate admissions, and a decrease in LOS. However, to reduce costs associated with these parameters may require, as Porter says, spending more on other services. In our case, the trade-off necessitates that stakeholders justifiably sustain HIEs. Of all stakeholders, accountable care organizations should be especially interested. Aligning physicians and payers in this endeavor should also optimize value.

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<tr>
<th>Table 6</th>
<th>Comparison of Raw Admissions and Maximum Length of Stay for Propensity-Matched Control and for Test Groups</th>
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<tbody>
<tr>
<td>Period</td>
<td>Test group LOS</td>
</tr>
<tr>
<td>Time of first emergency department visit</td>
<td>83 admissions; 53 days</td>
</tr>
<tr>
<td>Time of second emergency department visit</td>
<td>155 admissions; 120 days</td>
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</table>

LOS indicates length of stay.

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<tr>
<th>Table 7</th>
<th>Unadjusted Comparison of Average Length of Stay Rates for Remaining Control and Test Group Participants, after Removal of All Outlier Admissions (LOS ≥33 days)</th>
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<tbody>
<tr>
<td>Period</td>
<td>Test group</td>
</tr>
<tr>
<td>Time of first emergency department visit</td>
<td>81 admissions; 4.65 days</td>
</tr>
<tr>
<td>Time of second emergency department visit</td>
<td>152 admissions; 4.66 days</td>
</tr>
</tbody>
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Decrease in ALOS for the test group between emergency department visits = 4.65 \times (5.73/4.75) – 4.66 = 0.95 days per admission.

ALOS indicates average length of stay; LOS, length of stay.
Limitations

We need to account for several potential limitations to this study. First, although the use of propensity scoring methods to create test and control groups should minimize potential bias, any time data manipulation occurs, potential new risks from bias need to be acknowledged. Methods exist to minimize biases arising from such risks. Second, the use of HIE in our study groups was limited to emergency department visits. Although we can hope for bidirectional information flow in the use of HIEs, we cannot actually prove that. Therefore, the association between HIE use in the emergency department and decreased inpatient admissions from outside of the emergency department is just that, an association. We cannot necessarily prove a direct cause-and-effect relationship. Nonetheless, the results remain intriguing, such that we plan further study on what we found here.

Third, we cannot discount the potential impact of so-called human factors.

Although we believe that the use of HIE in emergency departments influences physician behavior outside of the emergency department, we do not actually know if this is the case. As Churchman notes, “knowledge resides in the user and not in the collection of information. It is how the user reacts to a collection of information that matters.” Physicians caring for patients have a lot of nonexchangeable information at their disposal and that information may certainly impact potential admissions as much as, if not more than, HIE use in the emergency department. Last, one cannot quantify “indirect” savings. Although we can estimate potential savings in arguing for HIE sustainability, we cannot quantify something that never happened. Nonetheless, the argument still stands through logic and through extension.

Conclusions

The impact of “direct” value is easily quantified: it is tangible, visible, and deduced from the evidence. The impact of “indirect” value is much harder to evaluate: it must be induced from the evidence. By definition, then, it is much harder to “see” indirect benefits, because they are hidden from view. When it comes to visualizing the impact of HIE, one can follow a similar line of reasoning. Having clinicians access HIE in the emergency department has already shown direct benefits in the form of an average savings of $26 to $29 per emergency department visit, as well as avoided inpatient admissions directly from the emergency department. Our current results build on that direct confirmation by adding indirect evidence for HIE value.

HIE availability in the emergency department is associated with an effect outside of the emergency depart-
STAKEHOLDER PERSPECTIVE

Significant Potential for Health Information Exchange in Enhancing Quality of Care and Reducing Hospital Admissions in the United States

As the US healthcare system continues a hoped-for and necessary evolution toward an increase in quality along with lower costs, the important variables of efficiency and effectiveness will become evermore important and crucial for optimum outcomes to be achieved. The potential of health information exchanges (HIEs) is significant for enhancing the quality of care, eliminating duplicate services, avoiding unnecessary hospital admissions, and decreasing the costs of healthcare.

PAYERS: This tightly controlled, well-conducted, and properly evaluated study by Dr. Tzeel and colleagues of the indirect benefits of HIE in reducing hospital admissions from emergency department visits is the type of study that is necessary to continue to evaluate and promote HIEs as a vital segment of enhancing positive patient outcomes in the US healthcare system. The direct benefits of HIE in an emergency department are prevalent in the literature and described well in this study from Humana. The question of whether HIE in the emergency department avoids unnecessary hospital admissions from outside of the emergency department is the central tenet of this study. The authors found a 28% greater probability of an admission when HIE is not available in the emergency department setting.

As has been described in the literature, the importance of enhancing and embracing health information systems is crucial for the overall improvement of the US healthcare system. Despite its promise, much remains to be done to fully implement HIE in the United States. Sharing of information in an efficient and effective manner has not been a prominent feature of the US healthcare system. Much remains to be accomplished from an organizational framework for benefits to accrue.2

Continued
The Affordable Care Act, which was passed in 2010 and was affirmed as constitutional by the US Supreme Court in June 2012, promotes and incentivizes implementation of HIEs as one cornerstone for improving healthcare delivery in the United States. In a study examining Canadian experts’ views of the progress in the United States relative to HIEs, a recommended strategy is to increase the direct engagement with providers and to develop the business case for HIE implementation on a broad scale.1

HIEs have been a prominent part of the British National Health Service for more than 4 decades. What was accomplished in the 1970s in the United Kingdom was the establishment of a foundation of policy, infrastructure, and systems of care, and the creation and acquisition of clinical computing applications, with strong reliance on financial and clinical incentives.4

PATIENTS: A significant opportunity exists for consumer and patient engagement in the system as well. Recent studies have highlighted the support of consumers for HIE, while also pointing out the need to provide those who have relatively less sophistication and means of monitoring their health records electronically with more education, access, and information regarding HIEs.5

Much remains to be accomplished in the United States; however, studies such as the one supported by Humana and presented here are necessary to pinpoint the exact direct benefits of HIE, as well as the indirect benefits that must be detailed, explained, and presented to many stakeholders in the process of moving HIE forward with tangible benefits to various segments of the US healthcare system.

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