



# Assessing the Benefits of Integrating Health Information Exchange Services into the Medical Practices' Workflow

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## Abstract

To examine whether integration of Health Information Exchange (HIE) services into office workflow would have an impact on ED visits and unplanned 30-day readmission amongst the patients who were treated at the medical practice. We designed and implemented a training program at a medical practice in Western New York over a period of three months between November 2016 and January 2017. During the program, a group of health IT professionals and clinical specialists trained the staff on how to appropriately use and efficiently integrate the HIE services in their workflow. We measured the effectiveness of the program using both qualitative and quantitative methods. We employed an Interrupted Time Series (ITS) analysis to examine the effectiveness of the program on reducing the number of patients who experience an ED visit or an unplanned hospital readmission within 30 days of initial discharge. After the implementation of the training program, the rate of unplanned hospital readmissions reduced by 2.7 patients per 1000 members per month and the rate of ED visits reduced by 6.3 patients per 1000 members per month. The results indicate that educating medical practices on how to efficiently utilize the HIE services, and especially the notification systems will significantly reduce the rate of ED utilization and unplanned 30-day hospital readmissions amongst the patients of medical practices.

**Keywords** Health Information Exchange · Interoperability

## 1 Introduction

The United States spends 17.4% of its gross domestic product on health care, more than any other country in the world.

Kim Fecher, Lauren McCarthy, Daniel E. Porreca and Niam Yaraghi have contributed equally.

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Despite this \$2.9 trillion expenditure, the quality and efficiency of the health care system in the US ranks last when compared to other developed countries.(Davis 2014) As a result, a concerted national effort to reform health care using information technology (IT) is well under way.(Yaraghi 2015) Electronic exchange of medical data is one of potential IT solutions for improving efficiency of healthcare services; it facilitates the timely access to patients' medical records, which is vital for providers to make better decisions and avoid redundancies. Fewer redundancies and better medical decisions will naturally lead to much needed savings in the health care system.

Health information can be exchanged through Regional Health Information Organizations (RHIOs). A RHIO is a multi-sided platform; on one side, health care organizations, which usually include laboratories and radiology centers along with major hospital systems and pharmacies, join the platform and upload their patients' data to the RHIO's database. On the other side of the platform, medical providers query RHIO's database and download the available medical information. The RHIO provides IT infrastructure and manages patient privacy(Yaraghi et al. 2019; Yaraghi et al. 2015) and data transactions between the members.(Yaraghi et al. 2014, 2013a, b)

Prior literature sheds significant light on our understanding of the benefits of HIE systems in different healthcare settings.(Unruh et al. 2017; Rudin et al. 2014; Buntin et al. 2011; Walker et al. 2005; Menachemi et al. 2018) However, there are still two major aspects of HIEs that yet to be examined. First, while HIE use has been studied in hospitals and emergency departments, its effects are yet to be known in outpatient settings, such as physicians' offices and medical practices. A notable exception in this area is the study by Eftekhari et al.(2017) who examined the impact of experience with HIE on reducing the number of repetition of medical procedures in physicians' offices. The current study complements the prior one by using a more robust measure for examining the outcomes of HIE use. While the first study was focused on repetitions, regardless of their medical justification, the current study uses more robust and widely accepted measures of hospital readmissions and ED visits as the outcome variables. Second, while researchers have studied the effects of HIE use, we know very little about the effects of efficient integration of HIE services into the practices' workflow. Although adoption and use of HIE has been proven to reduce redundancies in health care services and increase their quality, very little is known about the effects of suitable integration of HIE services. In this research, we bridge these gaps by answering the following two questions. First, how does HIE services affect the quality and cost of care at small medical practices? Second, how does implementation of a program to train clinical and administrative staff about various aspects of the HIE services and efficient integration of HIE into their workflow increase the efficiency of healthcare services provided at such small medical practices.

To answer these questions, we designed a customized HIE training program and implemented the program in a medical practice and integrated the HIE services into its workflow over a period of three months. We then use a mix of quantitative and qualitative methods to examine the effects of such program on the quality and cost of care as measured by ED visits and unplanned 30-day hospital re-admissions among the patients who visited the practice over a three-year period. The results indicate that the training program significantly reduces both the ED visits and re-admissions.

## 2 Methods

### 2.1 Setting

We examined the effects of integrating the services provided by HEALTHeLINK, the Regional Health Information Organization (RHIO) of Western New York into medical practices' workflow on 30-day readmissions and ED visits among the patient population that were treated by a medical practice in the region over the period of January 2016 to December of

2017. Established in 2006 as a result of collaboration and funding from the region's major hospital systems, health plans and grants from the New York state, HEALTHeLINK is connected to more than 85% of practices, all hospitals and many independent laboratory and radiology practices and long-term care facilities. More than one million Western New Yorkers have signed their consent allowing health care providers directly involved in their treatment to securely access their relevant medical information through the RHIO.

The RHIO provides multiple services. First, medical providers can receive the medical records of their patients from hospitals, laboratories and radiology centers directly into their Electronic Health Record (EHR) systems if they are technically compatible with the RHIO. This is commonly known as the *push* service. Second, providers can query the RHIO's database through a web-based platform and download the medical records of their patients into their EHR system, even if their EHR system does not automatically receive the medical records. This service, which is commonly known as the *pull* method, is usually used when the patient visits a medical practice for the first time and does not have any prior history with the practice. The third service of the RHIO is ADT notification system. Once a provider subscribes to ADT service, they will receive a notification as soon as their patients visit an Emergency Department (ED), or get admitted, discharged or transferred from a hospital in the region. The ADT notification system can be managed by the subscribers such that the clinicians, case managers and office staff can individually customize the notifications and actions per their own workflow needs and preferences.

Efficient customization and management of RHIO's services can significantly enhance the effectiveness and benefits of the services for the subscribers. The program that was designed, conducted and tested in this research was focused on training the support and clinical staff at the medical practices on how to best customize and manage the RHIO's services according to their needs and workflows. Such customization and integration were designed to increase the use of the RHIO services and their subsequent benefits in cost and quality of healthcare services. In the next section we provide description of the training program.

### 2.2 Intervention: HIE Training Program

A training program was designed and conducted over a three-month period between November 2016 and January 2017 at a medical practice in Western New York by a team of clinical and informatics specialists at the RHIO. The purpose of the training program was to optimize the use of the HIE services and help the medical and managerial staff at the practice to integrate the system into their workflow. We took the following steps in order to design and implement the training program.

The team first obtained the consent of medical practices who were willing to allow them to be present at their location to conduct the training. We chose practices that had either low or no utilization of the HIE services or had previously used it but then dropped off. Prior to the start of the training program, the focal medical practice in this study had only 4 active users compared to 14 after the training program. Meetings were held with the leadership of multiple medical practices in the region to conduct an in-depth review of the current status in each of the following areas: staff, physician and provider profiles, patient panel, current use of RHIO services and other sources of patient information, applicable practice use cases, and current patient wait time. In the online appendix A we list the details of the topics that were discussed in the initial assessment meetings.

Once the meetings were concluded, the team conducted a series of job shadowing at the location of the medical practices. During the shadowing, the team closely observed the current workflows at the medical practices and also interviewed designated practice staff and providers to get a close look at the duties and current workflow associated with a specific job role as well as to identify potential areas to incorporate the use of HIE services in the workflow. For example, the team observed that although ADT alerts were being delivered to the medical practice, there wasn't a workflow in place to manage them, and therefore such notifications were not being utilized to better manage the care of the patients in the practice.

Before starting the project, a pilot training program was conducted at a similar medical practice to allow the team to test and revise their tools and approach prior to working with the focal medical practice. Based on the feedback that team received through the above-mentioned steps, a training program was developed that focused on consent management, result delivery and querying as well as the use of ADT notification services.

The focal medical practice in which the final training program was implemented is located in northern Buffalo and has three physicians, two of which are internists and the other one specializes in family medicine. Additionally, one nurse practitioner and one physician assistant provide healthcare services at the practice. The average number of monthly patient visits at this practice ranges from 164 to 206 between the years 2016 and 2018. During the training program, a clinical specialist worked with the practice 3 days per week for five weeks. After that, the clinical specialist visited the practice

sporadically a few hours per week depending on their needs for another four weeks.

Training was also provided to each HIE user on how to use ADT notifications services as applicable to their job role. The training program consisted of two major components: consent management and HIE services. We describe these two components in the following.

To be able to receive ADT notifications and have access to medical records of their patients, practices should first obtain their consent. At the RHIO, the patient consent management is governed by the systems, processes and policies that enable patients to choose what health information they are willing to permit their healthcare providers to access and share as designated on a completed, signed, 'Authorization for Access to Patient Information' through RHIO's consent form. The practice can manage a patient's consent right at the point of contact allowing for quick, easy access to patient information if affirmative consent is given. The staff at the medical practice were trained on how to obtain the consent of their patients at the time of visits and enter the authorization in the RHIO's platform so that they can have access to the medical records of their patients for future visits.

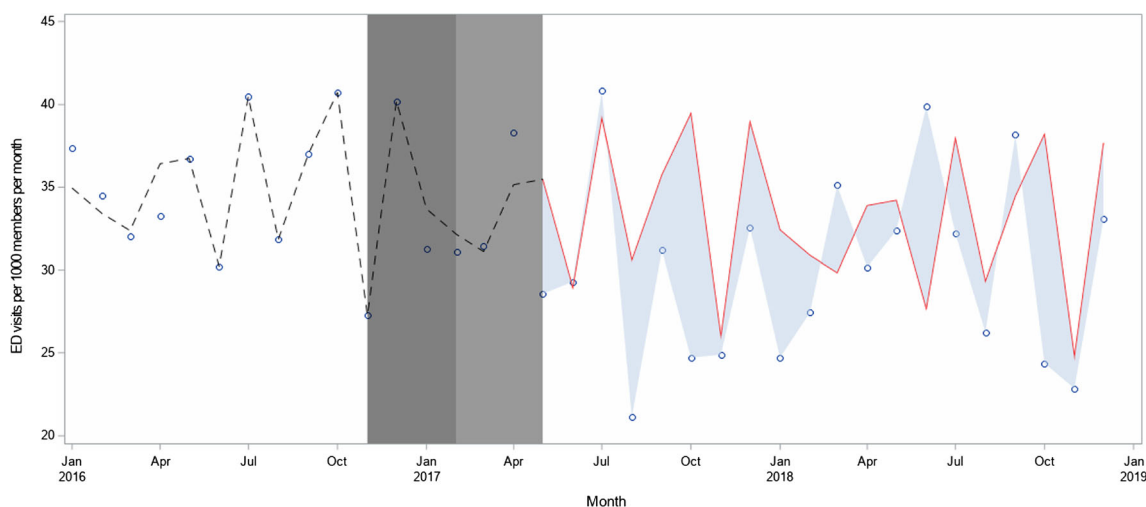
Training was also provided to all users about HIE services that included patient records lookup for instances where they did not have access to the prior records of the patient, results delivery for instances where medical records of the patients get delivered into the EHR system after consent is being acquired, and ADT notifications. Each of the users in the medical practice only received training on areas that were most pertaining to their job role. For example, the training for the front desk staff was focused on obtaining consent and entering the results into the RHIO's platform while the medical staff's training was focused on querying and viewing the medical records through the RHIO. Online appendix B provides an overview of the training program curriculum.

### 2.3 Quantitative Analysis

We use the unplanned 30-day hospital readmissions and the rate of ED utilization as two measures of quality and efficiency in the services of the medical practice. For each of these measures, we conduct an interrupted time series analysis. For the first measure, our dependent variable is the number of ED visits per 1000 members per month, and for the second measure, our dependent variable is the number of unplanned 30-day hospital readmissions per 1000 members per month. We

**Table 1** Summary statistics

Period	ED visits per 1000 members	Re-admissions per 1000 members
1/2016–04/2017	34.60	9.05
05/2017–12/2018	29.99	8.12
Reduction %	13.3%	10.2%



**Fig. 1** Number of ED visits per 1000 members per month and their counterfactual values had the training program not been implemented

fit the dependent variable in each period as a function of 3 main explanatory variables. The first is a continuous variable that counts the periods since the start of the time series. The coefficients of this variable capture the time trends. The second is a binary variable that indicates the start of the training program. This variable is equal to 1 if the period is after the implementation of the training program and 0 if the period is before the training program. The coefficient of the binary variable indicates whether there is a change in the outcome variable immediately after implementing the training program. The third is a continuous variable that counts the number of months since the conclusion of the training program. The value of this variable in periods before the implementation of the rules is equal to 0. The coefficient of this variable indicates whether there is a change in the slope of the outcomes after the implementation of the program with the trend in the pre-implementation period. To account for correlation in outcomes between consecutive periods, we follow the recommendations of Penfold and Zhang (Lu et al. 2014) to test and account for correlation in subsequent observations in the time series. Our test results do not indicate the need for including autoregressive parameters in the models (Hyndman 1993). We also examine the existence of seasonality in our time series and, where necessary, include seasonal dummies in our models to adjust for seasonal fluctuations in ED utilization and hospital readmissions.

**Table 2** Effects of the training program on the ratio of ED visits

Parameter	Estimate	Standard error	<i>p</i> value
Intercept	38.67285***	3.6177	<.0001
Time	-0.03534	0.2458	0.8871
Training program	-6.30449*	3.0467	0.0511
Time after training program	0.16562	0.2933	0.5783

\*\*\*: *P* < 0.01; \*\*: *P* < 0.05; \*: *P* < 0.1

We estimate the following model

$$y_t = \beta_0 + \beta_1 t + \beta_2 T + \beta_3 t_{after} + \beta_4 \mathbf{S} + e_t \tag{1}$$

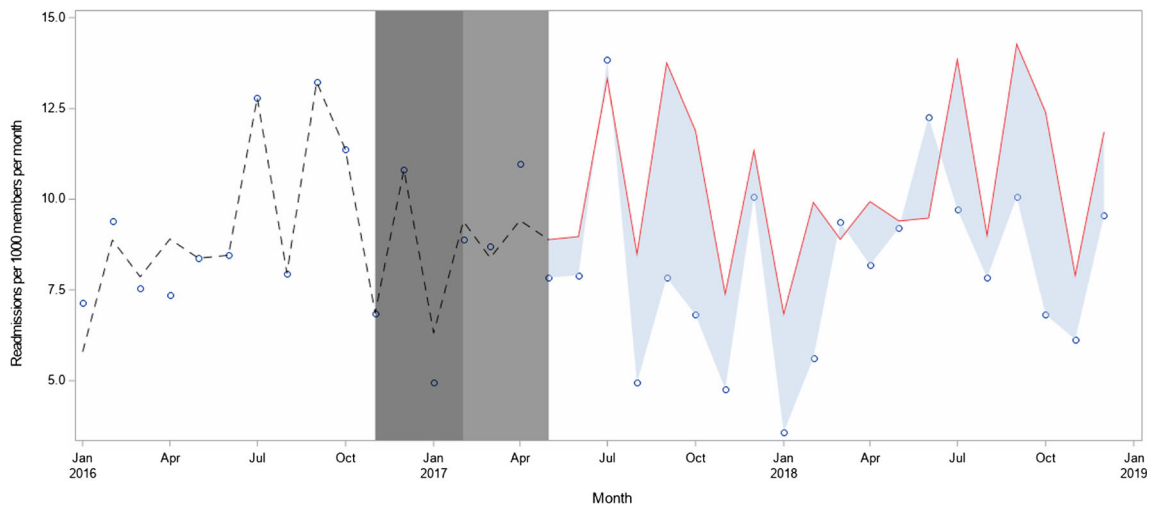
In equation (1),  $y_t$  indicates the value of the dependent variable (either ED admissions or 30-day hospital readmissions) in each month. Variable  $t$  indicates the months since the start of the timeseries, while variable  $t_{after}$  counts the months since the intervention went into the effect. Variable  $T$  is a binary variable which is equal to one in the months since the intervention. Finally,  $\mathbf{S}$  is the vector of the seasonal dummies. This method has been widely used in prior literature to examine the effects of policy shifts on various outcomes (Yaraghi and Gopal 2018; Ceccagnoli et al. 2012; Lee et al. 1999).

Note that the medical practice that has agreed to be a part of this study, may be different from other practices and have special characteristic that will help it to be better in terms of both adopting the HIE technology and also the medical outcomes and utilization of the services. We have tried to address this concern by examining the changes in the trends in readmissions and ED visits before and after the implementation of the pilot program at the same practice. Using the Interrupted Time Series method, we ensure that other factors that may have been influential in changing the outcome measures are already canceled out by comparing the performance of a medical practice with itself rather than comparing it with other practices.

**Table 3** Effects of the training program on the ratio of 30-day readmissions

Parameter	Estimate	Standard error	<i>p</i> value
Intercept	10.26672***	1.4272	<.0001
Time	0.07370	0.0957	0.4500
Training program	-2.71065**	1.2401	0.0403
Time after training program	-0.01022	0.1142	0.9296

\*\*\*: *P* < 0.01; \*\*: *P* < 0.05; \*: *P* < 0.1



**Fig. 2** Number of unplanned 30-day hospital re-admissions per 1000 members per month and their counterfactual values had the training program not been implemented

### 2.4 Qualitative Analysis

We augment our quantitative analysis with a qualitative interview with the staff and clinicians at the medical practice to better understand the effects of the training program. A customized exit interview template was created for the medical practice to assess and validate their adoption of recommendations and associated benefits and return on investment. The exit interviews were focused on two topics. First, discussion of the status of the adoption of recommendations made during the training program to incorporate HIE services into the practice’s workflow. Second, discussion of the benefits and return on investment associated with the training program and recommendations that the Practice had implemented. Specifically, during the interviews, we discussed how the practice measures the value of HIE services from a clinical quality and financial (administrative) perspective and whether the practice leadership believe it has had a positive impact on patient experience-of-care and staff satisfaction.

### 3 Results

During the period of January 2016 and April 2017, the average number of ED visits and hospital readmissions per 1000 members per month are, respectively, 34.6 and 9.05.

During the period of May 2017 and December 2018, the average number of ED visits and hospital readmissions per 1000 members per month are, respectively, 29.99 and 8.12. That is, the average number of ED visits and readmissions per 1000 members per month has reduced by respectively, 13.3% and 10.2% after the training program. These numbers are summarized in Table 1.

The visual inspection of the ED visits during the time period indicates that the effects of the training program were not observed until three months after the conclusion of the program. Other researchers in the healthcare context have observed similar lagged effects. For example, Yaraghi and Gopal (2018) note that the effects of HIPAA omnibus rules do not appear until two years since their implementation. The same phenomenon was observed by other researchers in healthcare related areas such as the effects of FDA labeling policies on reducing the use of aspirin (Soumerai et al. 1992) and antidepressant medications.(Lu et al. 2014)

### 3.1 Impact of the Training Program on ED Visits

In the following we estimate the effects of the training program on the ratio of patients that visit ED. Note that in this model, as shown in equation (1), we adjust for seasonal nature of the observations. The estimation results indicate that the number of ED visits per 1000 members per month reduce by 6.3 patients as a result of the training program.

Figure 1 graphically shows the effect of the program on reducing the utilization of ED per 1000 members per month. In this figure, the dots represent the actual ED utilization over the period of the study. The dark grey band show the time span of the training program while the light gray band show the three-month window from its conclusion until the emergence of the effects. The red line shows the counterfactual number of ED visits per 1000 members per month had the training program not been implemented. The shaded blue areas represent the difference between the actual and counterfactual ED utilizations. We observe that in most months, the actual number of ED visits per 1000 members per month is significantly smaller than their predicated counterfactuals, which shows that in the absence of the training program we would have observed a much higher number of ED visits. As shown in Table 2, the



implementation of the training program leads to a reduction of 6.3 ED visits per 1000 members.

### 3.2 Impact of the Training Program on 30-Day Readmissions

Analysis of the 30-day readmissions yields similar results. As shown in Table 3, the training program has resulted in reducing the number of readmissions per 1000 members per month by 2.7 patients (Table 3).

Figure 2 graphically shows the effect of the program on reducing the readmissions per 1000 members per month. In this figure, the dots represent the actual readmissions over the period of the study. The dark grey band show the time span of the training program while the light gray band show the three-month window from its conclusion until the emergence of the effects. The red line shows the counterfactual number of readmissions per 1000 members per month had the training program not been implemented. The shaded blue areas represent the difference between the actual and counterfactual readmissions. We observe that in most months, the actual number of readmissions per 1000 members per month is significantly smaller than their predicated counterfactuals, which shows that in the absence of the training program we would have observed a much higher number of readmissions.

### 3.3 Results of the Qualitative Interviews

The results of the exit interviews corroborate our findings from the quantitative analysis. One physician indicated that through HIE services, he is “able to find discharge summaries from hospitals that do not always send them to them. This is very important for hospital follow-up.” Another physician confirmed that “It is very useful to obtain results from other doctors”. HIE services save time by eliminating the need for making phone calls”. Another physician distributed HIE services as “Very helpful in retrieving results for patients who are coming in for medical clearances for appointments and ER records for hospital follow-ups as not all facilities automatically send reports to the patients’ primary care physician. Having this tool and being able to utilize it before the patients present for their appointment is an immense help in the flow of the appointment.”

## 4 Discussion

To the best of our knowledge, this is the first study that examines how training the clinical and administrative staff on HIE services and efficient integration of HIE into their workflow at outpatient settings would affect the quality of healthcare services. We described how the training program was designed and implemented over a three-month period in a medical

practice in Western New York and examined the effects of the program on the ED visits and unplanned 30-day hospital re-admissions over a three-year period. We found that the training program reduces the ED visits by 6.3 patients per 1000 members per month and reduces the re-admissions by 2.7 patients per 1000 members per month.

Although this study is focused on only one medical practice and its results may not be generalizable to other medical practices, its major strength is its high internal validity. By focusing on only one medical practice, we can ensure that other factors that could have affected the variation in outcomes are not influence our results and thus the findings are robust to factors outside of our model. Moreover, we corroborate the findings of our quantitative analysis by interviews with the clinical and administrative staff at the medical practice and found that they all have noticed a significant improvement in their workflow.

Given the findings of this study, we recommend that RHIOs expand their efforts to design and implement training programs that introduce the capabilities of the HIE systems to their users and educate them on how to best use such services in their work.

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