

## Final Report

Title: Use of push and pull health information exchange technologies by ambulatory care practices and the impact on potentially avoidable health care utilization

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## 1. Structured Abstract

**Purpose:** Health information exchange (HIE) technologies increase providers' access to patient information from multiple health care organizations. The objectives of this project were to increase our understanding of two different technological approaches to information exchange: "push" and "pull".

**Scope:** Despite its importance to state and federal health policy, the US has failed to fund a consistent HIE technological approach. Federal policy formally encourages HIE without distinction and Federal strategic plans and reports convey the idea that the "push" and "pull" approaches are equivocal.

**Methods:** Using providers in western New York state, we were able to measure both "pull" and "push" HIE. "Pull" or query-based HIE aggregates data from multiple organizations into a longitudinal, comprehensive patient record that reflects a patient's care from across the community. In "push" HIE, structured documents are sent from one provider to another. The project's two distinct studies used a combination of system log files and qualitative interviews and technology adoption records and Medicare claims, respectively.

**Results:** According to regression analyses, "pull" and "push" HIE are complementary approaches to HIE. "Pull" HIE usage higher for encounters with usage of "push" HIE for imaging information and clinical documents. Qualitative interviews were supportive of quantitative analyses. Among Medicare beneficiaries, provider adoption of "pull" HIE was associated with a 15% relative decrease in the probability of an ambulatory care sensitive hospitalization and a 1.2 percentage point decrease in readmission probability.

**Key Words:** medical informatics; electronic health records; health information exchange; community health centers; primary health care; Medicare;

## 2. Purpose

Health information exchange (HIE) technologies increase providers' access to patient information from multiple health care organizations. The objectives of this project were to increase our understanding of two different technological approaches to information exchange: "push" and "pull". Under the "pull" model of information exchange providers query community-wide, longitudinal patient record systems for patient information (also called query-based exchange). In "push" model of information exchange key electronic information is automatically delivered to providers (also called directed exchange). This project had two specific aims:

*Specific Aim 1: Determine whether primary care providers use "push" and "pull" as complementary or alternative approaches to health information exchange. We hypothesized that receipt of information via "push" will increase the likelihood of "pull" usage during a patient visit (i.e. the approaches are complementary).*

*Specific Aim 2: Quantify the effect of "push" and "pull" health information exchange on potentially avoidable health care utilization. We hypothesized that HIE will be associated with reductions in readmissions and hospitalizations for ambulatory care sensitive conditions.*

## 3. Scope

### Background

Better sharing of patient information underpins nearly all efforts at improving the US health system's quality, safety, and efficiency. Innovative strategies such as the Hospital Readmissions Reduction Program, and Medicaid redesign depend on providers' access to comprehensive and timely information. Health information exchange (HIE) is an intervention designed to meet such information needs by facilitating providers' access to electronic patient information from multiple settings. Health policy has already identified HIE as a critical driver of a better health system.

The Medicare Access and CHIP Reauthorization Act of 2015 “declares it a national objective to achieve widespread exchange of health information” and the Office of the National Coordinator for HIT recently condemned practices that interfere with HIE (i.e. blocking) in a report to Congress. The significance of HIE is further evidenced by federal and state funding. The State HIE Cooperative Agreement Program invested \$540 million towards states’ HIE infrastructure. Because certified electronic health records (EHRs) must be able to exchange patient information, the \$26 billion Meaningful Use Program is also an investment in HIE. Collectively, state and local HIE investments near \$1 billion. Despite its importance to state and federal health policy, the evidence-base for HIE as an effective intervention to change utilization, cost and quality has been criticized as insufficient.

### *Context*

Overall, HIE technologies increase providers’ access to patient information from multiple health care organizations. However, different technological approaches can accomplish this increased access to information.

“Pull” or query-based HIE aggregates data from multiple organizations into a longitudinal, comprehensive patient record that reflects a patient’s care from across the community. This approach is called “pull” because the acquisition of information from this patient record is initiated by the user. “Pull” HIE users have access to a consolidated view of patients’ demographic information, prior diagnoses, medication history, radiology reports and images, laboratory results, and discharge summaries from all participating providers

The “push” model of HIE closely resembles the faxing of paper records between providers or sending patient information via email. In “push”, structured documents such as test results and clinical care documents (CCDs) are sent from one provider to others. The term “push” reflects that fact that the act of sharing patient information initiates with the sender. The process may be automated so that key events, like the posting of test results, a hospital admission, or ED visit triggers the “push” of information.

However, the US has failed to fund a consistent HIE technological approach. Federal policy formally encourages HIE without distinction and Federal strategic plans and reports convey the idea that the “push” and “pull” approaches are equivocal. In practice, however, the relationship is more complicated than current US policy portrays. Push capabilities must be integrated into EHRs as part of Meaningful Use certification criteria, whereas pull capabilities need not be. In addition, the health information organizations may view the two approaches as in competition. The actual relationship between the two approaches has never been empirically established and neither approach is well-tested.

### *Setting & Participants*

This research focused on HIE adoption and usage among ambulatory care providers. While strong use cases of HIE exist in the ambulatory care setting (e.g. care coordination across transitions), the bulk of HIE research has focused on the emergency care setting. The series of studies under this award utilized samples of providers in Western New York State.

## **4. Methods**

This award included to distinct studies as part of the specific aims, outlined separately below.

Study 1: The complementary nature of query-based and directed health information exchange in primary care practice.

### *Study Design*

In a cross-sectional analysis, we modeled the usage of HIE associated with a patient visit. The study sample included all adult encounters (n=241,868) at three federally qualified health centers (FQHCs) serving urban and rural counties in Western New York State from 2014-2016.

### *Data Sources*

A combination of three datasets furnished a complete description of HIE usage for a given patient encounter. First, encounter data included patient identifiers, date/time, providers seen, and information on patient characteristics. Second, EHR system log files recorded laboratory results, imaging reports, and other clinical documents electronically delivered to the FQHCs. Third, web portal system log files from the Rochester RHIO provided records of provider usage of HIE. All data were linked through synthetic patient identifiers.

### *Interventions*

Our analysis focused on HIE usage associated with a patient encounter. We identified HIE activity occurring any time between the date of the patient encounter and the date of his/her most recent prior encounter. Usage of “pull” HIE was defined as any FQHC user’s access of the RHIO’s portal during this window. “Push” HIE usage was defined by the review and inclusion of any patient information delivered to a FQHC’s EHR during the same time window.

### *Measures*

We extracted several measures as potential control variables. These included: time of the visit (day of week & morning / afternoon), patient demographics (age, gender), diagnoses associated with the visit, comorbidity, if the encounter was scheduled or a same day appointment, the provider type seen during the visit (physician, nurse practitioner, or other), and the FQHC site’s average monthly HIE usage.

### *Analyses*

We measured the association between “push” HIE usage and “pull” HIE in a logistic regression model with cluster-robust standard errors. To provide additional insights about usage and the relationship of “push” and “pull” HIE, we conducted 8 telephone interviews with end users.

### *Limitations*

Log file-based analyses have several key limitations. First, we had no information on the need for, application of, or successful retrieval of specific data elements. We do not know which specific data elements or information gaps may have motivated individual usage of either “push” or “pull” HIE. Also, we do not know if usage met the end user’s information needs or which data elements were actually applied to the delivery of care. Additionally, while the study sample included multiple FQHCs, generalizability may be limited.

## Study 2: The associations between query-based and directed health information exchange with potentially avoidable use of health care services.

### *Study Design*

In a seven-year longitudinal panel of providers (n= 9,986) serving Western New York State, we modeled the association between HIE adoption and subsequent utilization of inpatient and ED services among Medicare fee-for-service (FFS) beneficiaries using fixed-effects regression models.

### *Data Sources*

We combined HIE participation data with claims. The Rochester RHIO supplied registration listings of all users of “push” and “pull” HIE services. The registration lists included adoption dates (e.g. dates of first HIE usage) for all practices, individual providers, and individual staff members for both types of HIE. We merged these data with a 100% sample of inpatient and outpatient claims for continuously enrolled Medicare FFS beneficiaries. Beneficiaries were attributed to the provider with the plurality of their outpatient evaluation and management claims in the calendar year.

### *Interventions*

The intervention of interest was the provider’s “push” and / or “pull” HIE adoption status. Each provider’s approach to HIE was measured separately at the quarter-level as a binary variable. At baseline, none of the providers in the sample had adopted either approach to HIE.

### *Measures*

We examined three distinct types of potentially preventable health care utilization. First, we determined if a beneficiary had an ambulatory care sensitive hospitalization (ACSH) using the Agency for Healthcare Research & Quality’s prevention quality indicators. Second, we determined if the beneficiary had a non-emergent emergency department (ED) visit during the quarter according to the NYC algorithm. Third, we measured hospital admissions that resulted in an unplanned 30 day readmission during the quarter. For each provider, we measured their gender, age, specialty, panel size, and practice size. For each beneficiary-level, we measured demographics, dual eligibility status, Elixhauser comorbidity scores for each year, and diagnoses of high prevalence chronic conditions.

### *Analyses*

The unit of analysis was the beneficiary-quarter. Linear regression models with provider and year fixed effects were used to estimate changes in the probability of potentially avoidable utilization for a Medicare beneficiary attributed to a provider using HIE compared to beneficiaries attributed to providers who were not using HIE.

### *Limitations*

First, the generalizability of these findings may be limited in terms of population and technologies. Second, potentially avoidable utilization among Medicare FFS beneficiaries was measured with three outcomes, but we did not explore other types of avoidable utilization. Third, we were only able to measure HIE adoption and not actual usage. Fourth, we were limited to provider and practice characteristics available from secondary sources and did not have information on clinic workflows or the level of integration between HIE and EHRs. Lastly, this study did not investigate, or test for, any causal mechanisms by which HIE may affect outcomes.

## **5. Results (Principal Findings, Outcomes, Discussion, Conclusions, Significance, Implications).**

The findings from the two distinct studies are outlined below and followed by overall project conclusions.

Study 1: The complementary nature of query-based and directed health information exchange in primary care practice.

### *Principal Findings*

Usage of “pull” HIE occurred in 3.1% of encounters and “push” HIE in 23.5% of encounters. “Pull” HIE usage was 0.6 percentage points higher for encounters with usage of “push” HIE for imaging information, and 4.8 percentage points higher with usage of “push” HIE for clinical documents. The probability of “pull” HIE usage was lower for specialist visits, higher for post-discharge visits, and higher for encounters with nurse practitioners. Key informant interviews indicated using “pull” HIE after getting information via “push” HIE to obtain additional information, support transitions of care, or in cases of abnormal results.

### *Discussion*

Quantitative and qualitative findings suggest that directed and “pull” and “push” HIE are used in a complementary manner in ambulatory care settings. The evidence that both HIE types are applied in health care delivery highlights a potential US health information technology policy shortcoming. If, as our study suggested, “push” and “pull” HIE are used in a complementary manner, then both HIE functionalities should be incorporated into EHR Certification Criteria. However, that has not been the case. The Meaningful Use Program (now the Promoting Interoperability Programs), which has been the most significant driver and definer of interoperable health information technologies for nearly a decade, only includes “push” HIE requirements. Without specific criteria that support query-based exchange, like required single sign-on or health information organization exchange participation, it is not surprising that “pull” HIE usage was less common.

### Study 2: The associations between query-based and directed health information exchange with potentially avoidable use of health care services.

### *Principal Findings*

Adoption of “pull” HIE was associated with a lower probability of an ACSH. The marginal effect of “pull” HIE adoption was a 0.22 percentage point ( $p=0.037$ ) reduction in the probability of a beneficiary experiencing an ACSH. This represented an estimated decrease from a 1.6% to a 1.3% likelihood of an ACSH (or a 15% relative decrease) in a given quarter. Likewise, adoption of “pull” HIE was also associated with lower rates of unplanned 30 day readmission. Adoption of “pull” HIE was associated with a 1.2 percentage point decrease in the likelihood of readmission ( $p = 0.009$ ) for a hospitalized beneficiary. This was equivalent to a decrease from an unplanned readmission rate of 10.3% without any HIE to a rate of 8.9% with “pull” HIE adoption. “Pull” HIE adoption was not associated with ED visits. “Push” HIE adoption was not associated with any outcome.

### *Discussion*

In a sample of providers, adoption of “pull” HIE was associated with reductions in both ACSHs and unplanned 30 day readmissions among Medicare FFS beneficiaries. Prior studies of the association between “pull” HIE and readmissions and/or ACSHs have been largely cross-sectional and with mixed results. This study presents stronger evidence that “pull” HIE may be a strategy to reducing avoidable utilization. Contrary to expectations based on prior research, “push” HIE adoption was not associated with reductions in potentially avoidable utilization.

### *Overall Project Conclusions*

Overall, this project successfully increased our understanding of two different technological approaches to HIE. Critically, this study provided evidence of the complementary nature of “push” and “pull” HIE in meeting health care providers’ information needs while delivering primary care services. In addition, this study provided strong evidence that HIE, and particularly “pull” HIE, is an approach to reducing potentially avoidable utilization.

### *Overall Project Significance & Implications*

This project was one of the first to examine multiple approaches to HIE within the same set of studies and analyses. In doing so, we were able to explore a key issue of current health information technology policy in the US: what technologies should we support in order to increase access to information. From both studies included in this project, we have evidence that national and state health information technology policy should at a minimum place equal weight on facilitating and encouraging both “pull” and “push” HIE. For example, the complementary nature within workflows suggest both contribute to the care delivery process. In addition, the fact that “pull” HIE was associated with reductions in utilization, but not “push” HIE, indicates the need for incentives and certification requirements to encourage the usage of “pull” HIE. Also, the reliance on both approaches within workflows suggests the need for developers to increase integration between pushed and pulled information through context-aware systems, single sign-on, or notifications within EHRs.

Moreover, this project provided very strong evidence about the effectiveness of HIE as an intervention to improve health care delivery. By using longitudinal data on a key population (Medicare beneficiaries), this project supports a much stronger inference about HIE as an intervention than much of the prior work, which has been largely cross-sectional.

### **6. List of Publications and Products**

1. Vest JR, Unruh MA, Casalino LP, Shapiro JS. The complementary nature of query-based and directed health information exchange in primary care practice. *J Am Med Informatics Assoc* [Internet] 2019 [cited 2019 Oct 14]; Available from: <https://academic.oup.com/jamia/advance-article/doi/10.1093/jamia/ocz134/5583717>
2. Vest JR, Unruh MA, Shapiro JS, Casalino LP. The associations between query-based and directed health information exchange with potentially avoidable use of health care services. *Health Serv Res* [Internet] 2019 [cited 2019 Oct 14];54(5):981–93. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/1475-6773.13169>