

Using Health Information Exchange: Usage and Perceived Usefulness in Primary Care

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Abstract

Health information exchange (HIE) is seen as an essential technology for improving health care quality and efficiency by allowing exchange of patient-centered data over time and across organizations. The objective of this study was to evaluate the usage and the perceived usefulness of a nationwide HIE in a centralized model that was implemented in 2013 in the province of Quebec, Canada. A mixed-method study was conducted with a longitudinal descriptive analysis of usage data combined with in-depth comparative case study in four selected primary care organizations and two emergency departments. Perceived benefits were reported by users across all dimensions of care performance, including accessibility, efficiency, quality and safety, and patient experience; however, the experience of users was very heterogeneous and strongly associated with the commercial electronic record system available in their work place and the implementation strategy.

Keywords:

Health Information Exchange; Electronic Health Records; Quality of Health Care

Introduction

Allowing for information exchange along the care continuum is seen as an essential component of a high quality and efficient health care system.[1,2] Around the world, many jurisdictions have implemented standards or systems to allow for this electronic exchange to be possible.[3] In short, two types of models are emerging: on one hand, the centralized model, with national or regional shared records that are available to authorized providers and/or patients in various fashions, such as in Finland and Sweden, and on the other hand, the federated model, where individual organizations share information based on exchange protocols, as is done in the United States.[4] The information available for exchange is highly variable from one jurisdiction to another and ranges from imaging information to hospital discharge summaries.[5] In primary care, where care is by definition anchored in the patient's life, information continuity is particularly challenging, and the promised benefits of HIE are especially important. For example, a study conducted in the state of New York demonstrated that when a general practitioner accessed the regional HIE in the 30 days following the hospitalization of one of his or her patients, the risk of readmission for the same problem as the original hospitalization dropped by 57%. [6]

In Canada, Quebec was the first province to implement a province-wide HIE in a centralized model, starting with medication, laboratory, and clinical imaging information. The

objective of this study was to evaluate the usage and the usefulness perceived by users in primary care with this system, 2 years after its full implementation.

Design of the System and Available Features

The Ministry of Health manages the HIE in Quebec by for the entire healthcare system. It was built as a pull model, with central data warehouses, where every authorized provider is allowed to access and retrieve data depending on local certifications. All residents of the province (estimated population 8.2 million) are identified using their unique health insurance numbers. A secure connection between retail pharmacies, medical clinics, laboratories and diagnostic imaging centers allows for information to be transmitted to central warehouses.(for a detailed description of the medication domain, see a previous study [7]) A number of options are available to clinicians to access this information depending on the tools available at their work sites. Clinicians can use their electronic medical record (EMR) application if it was certified by the Ministry for interoperability. Ten different EMRs were certified in 2018, nine for primary care providers (outpatient EMR, O-EMR) and one for hospital-based providers. Alternatively, a web-based Viewer application can be used that was developed by the Ministry of Health and enables data access without EMR application. To access an individual patient's information through the Viewer, users need a certificate of security that was provided by the Ministry of Health on a USB device, combined with a password. As of Jan 2018, devices were distributed to 53,000 individuals in the province.

Users who access data through their EMRs are able to both view the patient's information, and import it, in a more or less structured format depending on the type of information and the commercial EMR they are using; however, users accessing data through the web-based Viewer only have the ability to view and print the patient's information.

Methods

Study Design and Data Collection

A mixed-method concurrent study was conducted, from January 2016 until December 2017. First, a descriptive analysis of usage was performed, using audit trails on accesses to the HIE obtained from the Ministry of Health. Information available for each access to the HIE included user ID, date, user role (e.g. physician, nurse, pharmacist), and which tool was accessed the HIE (e.g. Viewer, EMR1, EMR2). Second, an in-depth comparative case study was conducted, where a case was defined as a medical clinic or an emergency department, where

clinicians declared using the HIE regularly. Purposeful selection of cases was performed in an exploratory phase, where the criteria for selection was clinicians' regular system usage that was assessed using usage data combined with exploratory interviews with stakeholders in the province. In each targeted organization, the manager was invited to participate and to invite clinicians to an interview and an observation session. All clinicians (nurse, physician and pharmacist) were invited per site. Table 1 describes the cases selected, as well as the participants in each case. After consent was obtained, semi-structured interviews were conducted with users (24 general practitioners, eight nurses, nine pharmacists) following an interview guide with open questions about their usage of the HIE, their satisfaction, and their perception of the usefulness of the system in relation to their daily activities. Observation sessions were also organized at each site to complete interviews and describe usage practices.

Data Analysis

Adoption was estimated using the number of actual users compared to the potential number of users, per role. A user was defined as an individual who accessed the HIE at least once in October 2017 (this month was selected as a typical month of usage because individual users could not be followed during the whole study period due to replacement of user IDs without mapping between old and new IDs). Descriptive statistics on the proportion of potentially authorized users who actually accessed the HIE was calculated, according to the users' roles. The proportion of users accessing the HIE by tool was also calculated in Oct 2017 to describe usage. Finally, to describe the level of use for each data domain, the number of accesses to each domain was calculated by user for each week in 2017.

All audio files were transcribed verbatim, and thematic content analysis was performed using the framework proposed by Lau and colleagues (quality of the information and the system, usage patterns, perceived usefulness) [8]. Emerging codes were also allowed until saturation of the findings. Preliminary reports were shared with the participants at each site, and their comments were included in the final analysis. Adoption and level of use were combined with case study results to analyse the users' experience. The ethics committee of the Centre Hospitalier de l'Université (CHU) de Québec and McGill University approved this project.

Table 1 – Organizations Selected and Participants at Each Site (GP=General Practitioner; phm = Pharmacist; nurse = Clinical Nurse or Nurse Practitioner, ED = Emergency Department)

Site	Tool available for HIE usage	Participants
Family health team 1 - Urban region A	O-EMR 1 + Viewer	9 GPs, 1 nurse, 1 phms
Family health team 2 - Rural region	O-EMR2 + Viewer	3 GPs, 2 nurses, 1 phms
Family health team 3 - Urban region B	O-EMR3 + Viewer	3 GPs, 1 nurse, 1 phms
Family Health Team 4 - Urban region A	O-EMR4 + Viewer	3 GPs, 3 nurses, 1 phms
ED Academic Health Center 1 Urban region A	Viewer	2 GPs, 3 phms
ED Academic health center 2 Urban region A	Viewer	4 GPs, 2 phms, 1 nurse

Results

Usage of the HIE

Adoption

Table 2 presents the number of users compared to the potentially authorized users per role. Overall, adoption was higher in primary care, where the vast majority of pharmacists (78%), general practitioners (74%) and nurse practitioners (72%) in the province accessed the HIE in October 2017. Interestingly, only 26% of specialists accessed the tool. The Viewer was used by 89% of users in October 2017, while only 17% of users accessed the HIE using an interoperable EMR (Table 3). While more than 90% of GPs in the province have access to an interoperable EMR in their workplace, only 50% of GP users accessed the HIE using their O-EMR, while 74% of GP users accessed the HIE using the Viewer, indicating that a rudimentary adoption of the HIE is high, while the adoption of more advanced features linked to HIE integration still needs to be improved. Finally, only 12 % of specialist users accessed the HIE using an integrated EMR.

Table 2 – Number of Users by Role in Oct 2017

Role	N potential users ¹	N Actual users (% ²)
Physicians (total)	20,052	9,612 (48%)
General practitioners	9,503	6,992 (74%)
Specialists	10,239	2,620 (26%)
Pharmacists	9,212	7,162 (78%)
Nurses (total)	74,469	8,762 (12%)
Nurse practitioners	413	297 (72%)
All roles	NA	31,915

¹Data obtained from the annual reports of the respective professional associations; ²actual users / potential users

Table 3 – Number of Users by Tool, Selected Roles in Oct 2017

Role	N users ¹ (% ²)	
	EMR	Viewer
General practitioners	3,496 (50%)	5,187 (74%)
Specialists	309 (12%)	2,428 (92%)
Pharmacists	102 (1%)	6,790 (94%)
Nurse practitioners	146 (49%)	232 (78%)
All roles	5,571 (17%)	28,395 (89%)

¹Users may have accessed with more than one tool (sum >100%)
²Access with a pharmacy management system is not presented; ²=N users with this tool / N actual users with this role (table 2)

Level of Use

The medication domain was the one with the highest number of weekly accesses by physician users, in comparison to the lab and imaging domains, with an average of the mean number of weekly accesses per user of 21 for meds, six for labs and seven for images. Figure 1 presents detailed weekly accesses by tools, per domain. For the medication domain (Fig 1A), the number of weekly accesses using an outpatient EMR (O-EMR) was higher when compared to the Viewer and an EMR in the acute care setting (mean ± SD : 35 ± 4 vs 17 ± 1 vs 10 ± 1 respectively). This was aligned with the available feature of the O-EMR confirmed with the case study, where only these tools in outpatient settings had the availability of the most advanced feature for importing granular medication data from the HIE, to be reused for clinical activities, such as generating a new electronic prescription. In the lab domain (Fig 1B), the level of use was similar for O-EMR and Viewer, and lower for EMRs in the acute care setting. For images (Fig 1C), the level of use

was higher using the Viewer application. This might be related to the fact that the image was only accessible using the Viewer application, while O-EMR and EMR only provided access to the report.

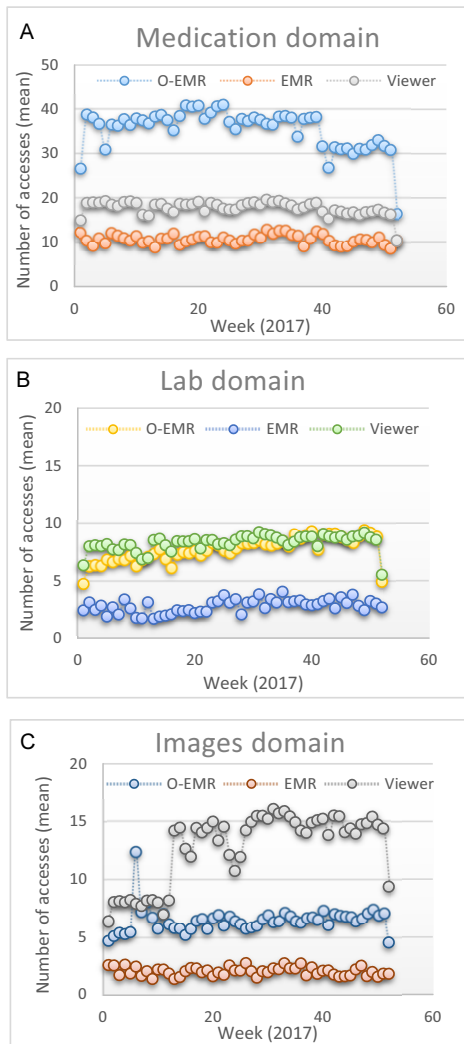


Figure 1. Level of Use of Each Data Domain of the HIE by Physician Users in 2017, by Tool Used to Access the HIE (O-EMR = Outpatient Electronic Medical Record; EMR = Electronic Medical Record) (Scale for Graph A is Different)

Perceived Benefits in Primary Care

Benefits associated with HIE usage were identified across all cases, by a comparative analysis, highlighting differences and similarities among and between cases. Interestingly, perceived benefits were similar across cases, and rapidly saturated in terms of how using the HIE impacted care quality, productivity, and the experience of patients. The diversity of perceived benefits was great and aligned with what is already documented with such clinical information sharing in other settings.[9–11] They were also aligned with the expectations associated with the implementation of the HIE.

Overall, the added value seemed greater for medication information, while this was the only source of information in

all cases visited. On the other hand, in the lab and imaging domains, the added value depended on the regional organization and available tools in the workplace. Indeed, other systems in place in some regions for electronically sharing this information were making a difference.

To be precise, perceived benefits were reported across all dimensions of care performance : productivity, quality and safety, accessibility, and experience of patients (Table 4). According to users, these benefits are actualized, because the information accessible through the HIE is of greater quality: more complete, more reliable, more valid and available when needed. For productivity, clinicians perceived that using the HIE reduces delays related to clinical information management (e.g. receive active medication list, lab results or imaging reports by fax), thus reducing delays for patients, reducing duplication of exams, and dedicated (avoidable) resources. Then, the users perceived that the quality and safety of care was improved, thanks to a better informed clinician, who is more confident about the clinical judgement based on a more accurate portrait of the patient, thus reducing errors and improving continuity. Similarly, the participants perceived that access to care was improved, in particular for general practitioners, who mentioned that they were less reluctant to register complex or vulnerable patients who became less difficult to follow with this kind of tool facilitating care coordination through clinical information sharing. Finally, some clinicians reported that the experience of their patients was improved, particularly in relation to timely access to information and reduced unnecessary visits.

Table 4. Perceived Benefits Associated with HIE Usage

Productivity
↓ Delay in getting information
↓ Delay in receiving results
↓ Duration of visits
↓ Duration of care episodes
↓ Duplicate exam
↓ Avoidable visit
Quality and security
↑ Confidence in decision making
↓ Errors
↑ Appropriateness of care
↑ Continuity and coordination of care between the team members and different healthcare organizations
Accessibility
↑ Volume of patients
↓ Waiting time
↑ Management of vulnerable and complex patients who consume healthcare services
Patient experience
↑ Relationship with clinicians and teams
↑ Comprehension and involvement
↓ Unnecessary visits and wait times
↑ Satisfaction

Legend : ↑ = Improve or Increase; ↓ = Decrease

A Very Heterogeneous Journey

However, the experience of users, a mediating factor in the actual level of use and persistence over time, was highly heterogeneous and closely associated with the commercial tool available on the work site, as well as the implementation strategy. While in some organizations (family health team 1 (FHT1) and FHT2), using the HIE was reported as easy and was highly integrated in the daily activities, in some other organizations (FHT3, FHT4, ED1, ED2), using the HIE was

only motivated by certain specific situations, where the added value was high enough to compensate for the efforts and irritants reported by users to access and integrate the clinical information from the HIE in routine clinical activities. The main barriers were related to the completeness of the information, the usability of the applications, the performance of the system (e.g. some long periods of shut downs), and the process for access (a pull system requiring a USB device on a physical desktop) not well aligned with the fluid nature of care.

When is Using HIE Worthwhile?

In the ED, the added value was clear and very high, for almost every patient but especially when the patient was unconscious, unable to communicate for various reasons, or when the clinician had a doubt about the veracity of the story from the patient; however, both EDs had access to the HIE only through the Viewer application, with limited integration into their work flow and basic features of viewing information. In medical clinics (family health teams), the added value was particularly high for patients with chronic conditions, navigating through the health care system with a long trajectory requiring clinical information sharing or for walk-in clinics when patients were not known.

Discussion

To our knowledge, this is the first study conducted with HIE users in Canada. While evidence of HIE positive outcomes are growing [12,13], it is important to deepen our understanding of the different systems, and associated users' experience across different jurisdictions. The actual experience of users, and thus the potential outcomes, are highly related to the availability of given features, and their levels of use by many health care professionals, in a given setting.[14] Our results highlight the fact that one dimension needs to be deepened when studying HIE, namely the integration within the main tool used by healthcare professionals, i.e. the commercial electronic record available in their work place. While a recent systematic review conducted by Menachemi and colleagues [13] highlighted the fact that most studies with positive outcomes were associated with American community HIEs, one should consider what it means in terms of newly available information, and the actual features available for a given clinician, in a particular setting. As already described by Opoku and colleagues in the US, this is strongly associated with the health care system organization, and underlying systems [15]. Nonetheless, what this means in other jurisdictions is poorly described. This is where this study makes a contribution by deepening the description of an HIE in Canada.

First, adoption was higher in primary care, with almost three quarters of general practitioners, pharmacists and nurse practitioners in the province accessing the HIE. Moreover, perceived usefulness by clinicians in family health teams and emergency departments was important, with a diversity of benefits identified by users. The added value seemed significant for clinicians in these cases, even if some barriers were mentioned as to the quality of information and of the system. This relates to previous studies in Finland [9], New York state [6,8–10], and Midwestern states [16], highlighting the benefits of HIE especially for primary care providers, and emergency department physicians.

On the other hand, a lower adoption rate by specialists was observed, which may be related to many factors. First, most of these physicians work in hospitals, where the availability of an integrated EMR with an HIE is scarce, and most clinicians only have access to the Viewer application to access the HIE. In fact,

most hospital centers in the province do not have an advanced EMR available, and paper charts are still the norm as the basis for the integration of clinical information. Moreover, the added value of the HIE is lower in acute care centers, because what you can do with the Viewer application is very basic : view and print clinical information. While very useful in the emergency department, to complete the medication list, and review lab results and imaging reports from other organizations, as a way to get a quick overview of a patient and his or her recent care episode, it does not seem to be enough for specialists to access the system in their usual patient care. Furthermore, the performance of the system for viewing images is not satisfactory for diagnostic purposes, and the PACS (picture and archiving communication system) already available on a regional basis in the province reduced the added value of the HIE.

Interestingly, the HIE in the province of Quebec was the first clinical information system integrating information between primary care and acute care settings, and integrating information between private and public organizations. In Quebec, most hospitals are publicly owned, and clinicians practicing within these organizations have access to some form of an integrated system while all pharmacies are privately owned, and about 30% of lab centers and imaging centers are private organizations.

Overall, it is important to note that HIE is a generic term to describe clinical information sharing, but what is shared, and how it is integrated into clinical and cognitive workflows, are crucial to benefit actualization. This study is one step ahead on this road in that it highlights the fact that the **added value** associated with HIE needs to be considered **in comparison** to other available systems in a given setting. In other words, two main questions need to be considered around such systems: 1) what it adds to what is already known about a given patient (quality of the information); 2) how easy and quick it is to use the clinical information from the HIE versus the other available systems (quality of the system).

This study has a few limitations. First, only a few cases were selected in three regions of the Province (out of 18), thus limiting the external validity of the findings. While triangulation of data sources and types allowed us to present interesting findings, further research is needed to deepen our understanding of the actual practices in a more diverse sample of work sites. Moreover, this study was conducted in the early phases of the implementation of the integrated EMR/HIE features. Some users were not very familiar with these features when we visited their work site, and further research should investigate routine practices when users are more experienced with their interfaces.

Conclusions

This study was able to describe the level of use of the HIE at the scale of the whole system in the province of Quebec, and characterize the perceived usefulness for clinicians using the system. Interestingly, the adoption is higher in primary care and at the emergency department, where the added value of the system is higher. Further research is needed to deepen our understanding of the heterogeneity of usage practices of the HIE, particularly with different commercial EMR and their specific integration features, as well as the various factors associated with perceived usefulness and outcomes actualization.

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