

A Regional Health Information Exchange: Architecture and Implementation

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Abstract

The MidSouth eHealth Alliance's health information exchange in Memphis, Tennessee provides access to data on almost 1 million individuals. The effort is the product of a comprehensive, integrated approach to technology and policy that emphasizes patient-centered use, low-cost, flexibility, and rigorous privacy and confidentiality policies and practices. It is used in emergency departments and other clinical settings. This paper provides a high-level overview of the system and its use. The early anecdotal success of this effort and preliminary formal clinical and financial evaluation suggest that health information exchanges can improve care at relatively low cost.

Background

The MidSouth eHealth Alliance (MSeHA) was formed in response to 2004 planning efforts initiated by Governor Phil Bredesen, Shelby County Mayor A.C. Wharton, Vanderbilt University, and the health care leaders in the Memphis, Tennessee Region [1]. Focused initially on hospital delivery and pressing financial crises in the region's large county hospital, the planning effort demonstrated that pressing health care issues were not restricted to one hospital or neighborhood but instead encompassed every neighborhood, every payer class, and every health care delivery organization. Emergency department care was identified as a initial means by which trust and results could be obtained among traditionally competing organizations. The Exchange was first used in clinical settings in May of 2006 and its use has increased ever since. It is governed by a non-profit corporation and managed through a Board, a program management office, and various committees. Data sharing agreements based on the Markle Foundation Connecting for Health Framework dictate the responsibilities of institutions and individuals participating in the exchange. Funding is provided by AHRQ, the State of Tennessee, Vanderbilt University, and local resources. The effort does not receive funding through NHIN contracts.

The Coalition

More than 9 non-profit, for-profit, and government groups representing some 15 institutions contribute data in real-time. MSeHA's governance is open and participatory. Governance includes health care delivery organizations, county government, state government. Working groups were created for clinicians and health care information technology professionals. An operations committee is responsible for consumer concerns over privacy and confidentiality and reports to the Board. Formal and detailed by-laws allow for broader participant inclusion and data use as the project evolves.

The Architecture

The Exchange's architecture is based on Vanderbilt University Medical Center's information technologies adapted to serve as a component in an evolutionary National Health Information Network [2, 3, 4].

Data are transmitted from each participant via virtual private networks to a logically separate "vault." Each vault is essentially a separate partition in a version of the Vanderbilt StarChart Database architecture. These data are maintained in their original format and technically remain under the control of the participant. Once data are used by another site, records of use and the values resident at that time are retained in audit logs.

This degree of individual institutional control afford the benefits of a “decentralized” exchange with the efficiencies of a “centralized” exchange. This degree of control was helpful when some organizations deleted all historical data used for testing prior real-time use of the system in clinical settings. Since each patient is given the opportunity to “opt out” at every registration event among member institutions, deletion of past historical data assured institutions that viewed by clinicians would be restricted to that obtained only after consent was obtained. Although clini-

cians regretted the loss of historical data, the large volume of data submitted after the system became operational quickly assuaged many concerns.

The architecture is a variant of the system in daily at Vanderbilt Medical Center. Admissions, discharge, and transfer data (ADT), other demographic information, and claims data elements are stored in a relational database. Clinical data are tagged by type and source so that they can be accessed in a uniform way across disparate sources.

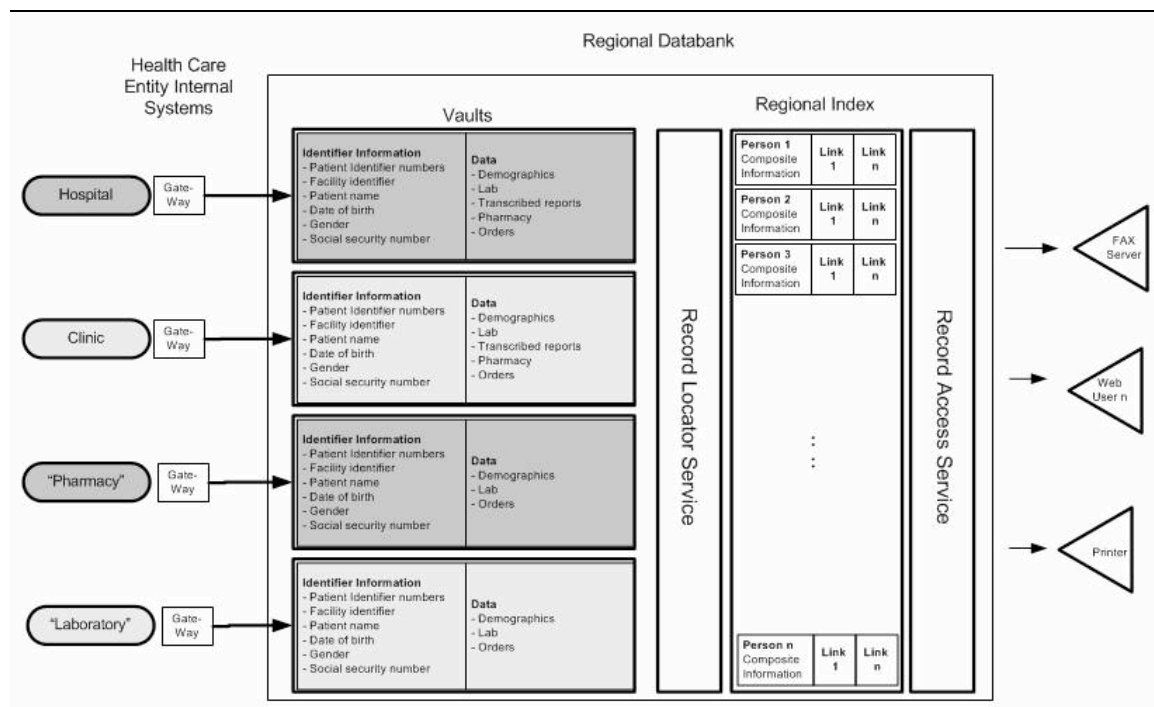


Figure 1. Architecture. Each organization publishes data in its native format to a logical database “vault.” Data are merged when queries are made and presented in a more uniform format.

Data are linked upon submission through a heuristic record matching algorithm. Matching elements are first name, last name, date of birth, gender, and (when available) social security number. Matching algorithms include the longest common substring method, character transposition checks, SOUNDEX on the last name and the New York State Identification and Intelligence System Phonetic Code (NYSIIS) on the first name. Each record is represented by a unique record ID and merged in a clique with other records for the same individual. Unique hospital record numbers are also retained. The system

does not employ a unique identifier for each person but instead relates any query to similar records based on the clique data structures. The record locator service has most characteristics essential to a master person index (MPI) and provides these services for a fraction of the cost incurred through commercial MPI systems.

Records are accessed through a separate record locator service based on the Markle Connecting for Health Framework. Searches can be performed through a known social security number, a medical record number from a participating institution, or a search employing name, date of

birth and gender. SOUNDEX and NYIIS techniques are applied and the user is presented with a lists of records asserted to be for the same individual. The list is composed of rows or visits that depict the name, date-of-birth, partial social security number, visit date and institution. No personal health information is displayed through the record locator service. If there appear to be two individuals but the differences are ambiguous, the user is presented with additional lists and event records can be “dragged and dropped” to create the correct set of records.

A “gold standard” test record set has been created to test the performance characteristics of the data matching and retrieval algorithms. At present, false positive matches are on the order of 1:10,000 and false negatives are in the range of 10%. Various techniques are used to allow a user to identify some of these false negative records with variants of their initial query. Probabilistic matching software has been tested with the system. Because its current performance characteristics are not superior to the current approach it is not yet employed in production.

The Database

Data elements from each site include some combination of patient demographics, encounter data, lab results, anatomic pathology reports radiology/imaging results, dictated reports (discharge summary, operation reports, cardiology reports), and ICD9-CM codes. All systems “publish” near real-time data. Registration events trigger display of record locator service information and will allow for additional alerts and triggers in subsequent releases.

Data are presented using a secure web browser. At present RSA secureID tokens and passwords are required to access the system. No efforts have been made to integrate access to the systems from each institution and the Exchange through a single sign-on. (Over time, adoption of common dual-factor authentication methods may simplify this formidable task). All use of the system is defined by data sharing agreements, participation agreements, and user agreements. These agreements were forged through consensus among approximately 50 institutional representatives over a period of nine months. A subset of this group serves as a formal operations committee reporting to the Board. This group advises the Board on legal and public responsibilities as other uses for the data are contemplated. Our current data sharing agreements are accessible at: <http://www.RegionalInformatics.org>. Auditing is

performed in real-time and is presently based on patterns associated with specific IP zones in service areas. Any use of the system outside of a registered IP zone leads to immediate notification. Our techniques have been demonstrated to detect and respond within minutes or hours to use outside of designated areas. To date, the few documented unauthorized uses have been by authorized clinicians employing the system for patient care outside of their usual setting.

Although data are published to the exchange in a wide range of formats, our approach allows for the consistent display of information across representations and encourages the evolutionary adoption of standards among institutions. Some data – such as common outbound laboratory messages – are represented in LOINC (logical observation identifiers names and codes). The few simple standardization efforts we have employed vastly improve data display and enable alerts and desired attributes essential for clinical decision support, reporting, and other valuable functions.

Users in clinical settings	381
Total number of encounters	2,120,000
Diagnosis codes records	2,663,753
Unique medical record numbers	1,342,099
Linkages among records	550,775
Unique patients	880,000
Procedure code records	283,623
Laboratory tests (daily average)	80,000
Dictated discharge summaries (daily average)	150
Chest radiographs (daily average)	1,200
Monthly white blood counts (9 hospitals, March, 2007)	51,975
Monthly microbiology reports (May, 2007)	25,709
Monthly chest x-rays (May, 2007)	34,996
Monthly labs (approximate)	2,400,000

Table 1. Representative database elements as of January 2008.

Use

The system is in use in every major emergency department in the Memphis area, by hospitalists, and in growing number of clinics emphasizing the care of the medically indigent. Over 380 clinicians use the data for clinical purposes. Different workflows (e.g., print summaries attached to ED charts, ad hoc queries, “whiteboards”) make

usage comparisons challenging. At present, approximately 3% of all ED visits include an active look-up of patient information. Within the ED population, approximately 13% of patients have data from another source within the past month; this latter number represents a realistic “upper bound” on usage that can be used as a basis for clinical value calculations. These utilization

numbers are lower than those used in previous financial models and argue more strongly for the need to extend health information exchanges across ambulatory, acute care, long-term care, and other settings [5, 6]. The status of the formal evaluation process is reported by Johnson *et. al.* in a separate paper in these AMIA Proceedings.

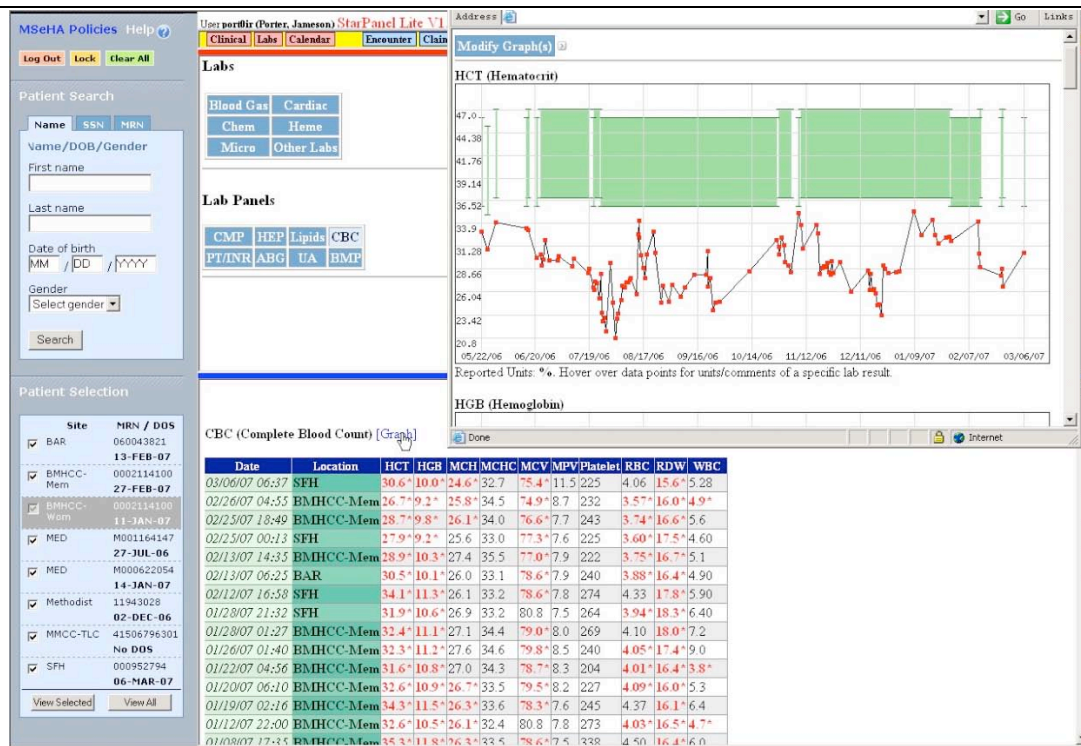


Figure 2. Example of the interface used in clinical settings. These lab data are represented in LOINC.

Preliminary Findings

Our work to date suggests that the technology aspects of health information exchange can be realized at a relatively low cost. Central to the approach is a minimal mapping and a decoupling of data from its use. Data sources and representations can evolve over time and use is constrained by consensual agreement and policy but not by technical limitations. Our work suggests that systems can link inbound records with a high degree of accuracy without employing a unique patient identifier or a formal master person index (MPI).

Our experience has demonstrated that cooperation among competing entities is possible if realistic expectations are set, “quick wins,” are achieved and costs are kept low. But a focus only

on hospitals and emergency departments is self-limiting. The success of the regional endeavor may require a re-formulation of the system to emphasize the perspective of the individual rather than the perspective of the provider. Rather than measuring the extent to which a system makes accessible clinical information from various institutions, a better metric may be to measure the extent to which the medical and health information required for an *individual* is available. This formulation leads to the conclusion that health information exchanges are a mechanism by which a region can serve as a proxy personal health record by providing some parts of a personal health record for everyone served within a region. The long-term value of such initiatives therefore may be to focus atten-

tion on the critical technical and policy issues that impede secure access and effective application of a broader array of health information required for safer and more effective clinical care.

Summary

Memphis Tennessee is the home of an operational health information exchange. This exchange incorporates strong policies and a relatively inexpensive and flexible architecture that allow participants to maintain control of their information and to participate at a relatively low cost. The architecture's flexibility has been demonstrated by various changes made in response to participant and user needs. Initial use in emergency departments has been positive. Use has had immediate clinical impact. Although ED use is only an early step for the Exchange, focusing on this restricted setting engendered trust provided participants with a sense of accomplishment. Anecdotal impact on patient care and provider perception have been uniformly positive. Although valuable in an ED setting, this architecture is not a panacea. A technology-enabled evolution from a provider-centric system to a patient-centric system will require the collaboration of a wide range of organizations and technical approaches.

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