Implementing health information exchange for public health reporting: a comparison of decision and risk management of three regional health information organizations in New York state

Andrew B Phillips,1 Rosalind V Wilson,2 Rainu Kaushal,3 Jacqueline A Merrill,4 with the HITEC investigators

ABSTRACT
Health information exchange (HIE) is a significant component of healthcare transformation strategies at both the state and national levels. HIE is expected to improve care coordination, and advance public health, but implementation is massively complex and involves significant risk. In New York, three regional health information organizations (RHIOs) implemented an HIE use case for public health reporting by demonstrating capability to deliver accurate responses to electronic queries via a set of services called the Universal Public Health Node. We investigated process and outcomes of the implementation with a comparative case study. Qualitative analysis was structured around a decision and risk matrix. Although each RHIO had a unique operational model, two common factors influenced risk management and implementation success: leadership capable of agile decision-making and commitment to a strong organizational vision. While all three RHIOs achieved certification for the public health reporting, only one has elected to deploy a production version.

INTRODUCTION
Health information exchange (HIE) is expected to transform the nation’s healthcare system through use of data from electronic health records to support care coordination, quality, research, and population health.1 2 States are taking the lead in establishing HIE networks.3 They face common challenges that include governance, technical data standards, policy issues, and sustainability. An improved understanding of how these challenges are managed is crucial for establishing policies to achieve national goals.

CASE DESCRIPTION
New York State (NYS) has aggressively pursued a statewide network for HIE since 2004, when the legislature enacted the Health Care Efficiency and Affordability Law for New Yorkers (HEAL-NY).4 This multi-year, multiphase capitol grant program aims to transform the organization and delivery of healthcare, consistent with national goals. The legislation also funded a public/private statewide collaborative process (SCP) to establish technical standards and policy, and an external evaluation entity.5 The program is managed by the NYS Department of Health (DOH). HEAL-NY phase 5 projects were aimed at developing the statewide health information network for New York (SHIN-NY). Health information entities applied for phase 5 funds by selecting to demonstrate one or more of the seven use cases predefined by NYS DOH during an award period that commenced in 2007.

The HIE for public health reporting use case describes bidirectional exchange of hospital, laboratory, radiology and hospital resource data between participating entities and NYS DOH via the SHIN-NY through subscription and response services defined by the use case (details in supplementary appendix, available online only). Exchange services include the patient identification/re-identification query (for case tracking and management), line list symptom or diagnosis query, and population-based analytic query (for public health reporting use case surveillance), and hospital resource query (for situational awareness of service capacity) (figure 1). These services are collectively referred to as the universal public health node (UPHN).6

We evaluated three regional health information organizations (RHIOs) that selected to demonstrate the HIE for public health reporting use case for their HEAL phase 5 award. The subject organizations serve over a third of the NYS population. They are: Long Island patient information exchange (LIPIX); Taconic health information network and community (THINC) in the Hudson Valley; and Western New York clinical information exchange (dba HEALTHeLINK). To our knowledge, this is one of just two studies assessing a state-level implementation of HIE for public health reporting.7 The Columbia University Institutional Review Board approved the study.

METHODS
The goals of the study were twofold: to document the process and outcome of the use case implementation and to identify assessment criteria and generalizable lessons learned. We conducted a comparative case study employing a three step method:8

Step 1: Define and design—Formative phone calls with individuals from each RHIO and their HIE technology vendors provided background information for semistructured interview guides, document requests, and agendas for site visits.
Step 2: Prepare, collect and analyze—we devised an extensive data collection plan that we carried out over a 2-year period. Each RHIO
received a day-long structured site visit and about 10 status checks via conference calls lasting 30–60 min. We acquired documents and artifacts including vision and mission statements, descriptions of organizational structure, HEAL-NY phase 5 applications, requirements and technical specifications, project management plans, and staffing profiles. We also acquired information during site visits, such as presentations and system schematics. We conducted supplemental interviews with representatives of the SCP and NYS DOH.

Transcripts of the tape-recorded interviews and electronic documents were processed using NVivo software. Through iterative review the evaluators identified broad themes to organize the large volume of material, and then coded text data under one or more broad themes. Non-textual data, such as tables and schematics were indexed to codes. The coded data were analyzed qualitatively, via constant comparison, data immersion, repeated questioning, probing and sorting. A modified Delphi approach was used to reach consensus on findings. This consisted of meetings between three evaluators, alternated with individual reviews, to distill the voluminous data into salient findings. A separate process was conducted for each RHIO, which produced individual case studies for comparison.

Step (3) Comparative analysis—The cross-case comparative analysis focused on risk management criteria. The organizing framework was a risk matrix, shown in table 1, which was developed by the evaluators, by drawing on factors identified by Wallace et al.14 We identified a set of risk-related decision points in the implementation process using this framework. Each RHIO’s responses were compared during a series of formal discussions among the researchers. We assessed leadership by considering how decisions conformed to the organizations’ mission and vision during periods of risk. Disagreements over sequence, context or content were discussed until consensus was reached.

RESULTS

The three RHIOs were similar in possessing consistent and capable leadership during the project, and each had a well-developed organizational vision and mission to guide decision-making. They differed in organizational and financial structure. LIPIX was formed by a regional hospital in 2004 and did not become fully independent until 2010. Membership fees from individual providers and institutions supported LIPIX, making value to stakeholders a key objective. HIE development was performed by in-house technical staff. THINC is uniquely sustained through public and private grants as an independent subsidiary of an independent physician practice association. HIE services are financed through data transfer fees paid by institutional stakeholders and subscription fees paid by physicians. HEALTHeLINK operates within a historically strong business community without individual provider fees but with ‘charter’ members, such as local payers or care systems, that provide baseline financial and planning support. HIE services including project management are outsourced to consultants and information technology vendors.

For assessment criteria we identified seven dimensions of risk posed by the project, each involving a strategic decision that emerged from an assessment of risk by the RHIO. In table 2 we summarize the comparative analysis of seven decision points associated with these risk dimensions, the decision/response by each RHIO, and relevant action(s) taken by NYS DOH.

Selection of the public health reporting use case

The first decision was to submit to NYS DOH a proposal for a HEAL-NY capital grant that elected to demonstrate the HIE for

Table 1 Six dimensions used to categorize and evaluate implementation risk

<table>
<thead>
<tr>
<th>Risk dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team risk</td>
<td>Issues related to the project team and resources, skills and knowledge available. Also refers to levels of cooperation and communication issues</td>
</tr>
<tr>
<td>Organizational/environmental risk</td>
<td>Risks associated with the environment of the project, including politics, stability and organizational support</td>
</tr>
<tr>
<td>Requirements risk</td>
<td>Uncertainty in the project requirements. Can refer to a lack of requirements, poorly defined requirements or changing requirements</td>
</tr>
<tr>
<td>Planning and control risk</td>
<td>Represents the risks associated with project planning, budgeting and timing. Integration with other projects is also considered here</td>
</tr>
<tr>
<td>User risk</td>
<td>The ability to obtain buy-in and acceptance from the users/stakeholders</td>
</tr>
<tr>
<td>Complexity risk</td>
<td>Risks associated with project difficulty and complexity of what is being implemented</td>
</tr>
</tbody>
</table>

Adapted from Wallace et al.14

Figure 1 Sample depiction of the bidirectional exchange of hospital, laboratory, and radiology data between participating entities and the New York State Department of Health. Information exchange is coordinated by regional health information organizations through subscription and response services defined by the health information exchange for public health use case (details in supplementary appendix, available online only). From New York State Department of Health.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision point:</td>
<td>Submit HEAL-NY phase 5 bid, select HIE for PH use case</td>
<td>Participate in statewide collaborative process</td>
<td>Delay in UPHN specification and development</td>
<td>UPHN web services specifications v.1.0 released by SCP</td>
<td>Goal adjustment and release of UPHN Open source database software released</td>
<td>Testing and certification Process</td>
<td>Implementation of HIE for PH in production environment</td>
</tr>
<tr>
<td>Risk:</td>
<td>Commit resources and ensure stakeholder buy in</td>
<td>Need specifications to begin building HIE solution</td>
<td>Loss of confidence Implementation delays and uncertainty</td>
<td>Fluidity of specifications</td>
<td>How data are structured and data fields are processed during subscription query and response limits its integration with vendor products for other reporting functions</td>
<td>Fail certification</td>
<td>Production level uncertainties and readiness of all parties</td>
</tr>
<tr>
<td>Risk dimension:</td>
<td>Organizational/environmental risk User risk</td>
<td>Planning and control risk Requirements risk</td>
<td>Complexity risk Planning and control risk Team risk</td>
<td>Requirements risk Complexity risk</td>
<td>Complexity risk User risk</td>
<td>Complexity risk User risk Organizational/environmental risk</td>
<td></td>
</tr>
<tr>
<td>Grantee/strategy/decision:</td>
<td>LIPIX</td>
<td>Submit bid: Decided to submit bid based on goal of NS-LIJ to create LIPIX RHIO LIPIX has clear sustainability plan to fund HIE development and business through anticipated fees</td>
<td>Develop RFP: Develop RFP for ‘LIPIX analytics’, which will serve as core functional software for HIE communication as well as provide reporting functionality for other business functions within LIPIX</td>
<td>Drop RFP: Stop work on RFP and take wait and see approach to HIE for PH implementation Resources assigned to other tasks</td>
<td>NO ACTION</td>
<td>Fully adopt open source database software: Open Source Software does not fully meet business needs so minimal development efforts taken to integrate with existing functionality. For example, manual re-identification process for patient data</td>
<td>Certification received: Certification received in December 2010. First to receive certification</td>
</tr>
<tr>
<td>HEALTHLINK</td>
<td>Submit bid: Agreed to go forward following feasibility study by outside consultant which showed clear financial benefit to stakeholders HEALTH-NY phase 5 will build on successful HIE activities from HIPAA and HealthNET Had prior experience through CDC and other similar projects</td>
<td>Finish prior development work: Complete work on legacy PHIN-HMS project as part of CDC communication pilot and develop working connection with large stakeholder</td>
<td>Strategic build of functionality: Build PH for HIE to known functionality, allocate resources (consultants) to other projects Vendor assumes some risk for HIE work, b/c sees business case functionality for other clients Vendor participates in drafting specifications as part of SCP</td>
<td>Continue development: Continue development of a Public Health Gateway based on adopted specifications</td>
<td>Build link to open source database software: Vendor develops ‘independent communication layer’ between public health gateway and open source database software</td>
<td>Certification received: Certification received based on using the communication layer developed by Axolotl Non-compete bid awarded, in part based on ability to offer a common communication layer for others to connect to open source software</td>
<td>Certification received: Certification received in December 2010. First to receive certification</td>
</tr>
<tr>
<td>THINC</td>
<td>Submit bid: HEAL-NY 5 PH use case in alignment with organization (IPA and THINC) philosophy and goals</td>
<td>Move forward: Become active participant in statewide collaboration. Confident in knowledge of NYS future direction and requirements</td>
<td>Complete work on UPHN: Development risk assumed by vendor and clients</td>
<td>Modify solution: UPHN solution modified to comply with specifications released by the SCP</td>
<td>Link with open source database software: Additional rework done to link to open source database software</td>
<td>Certification received: Certification received from State</td>
<td>Certification received: Certification received from State</td>
</tr>
<tr>
<td>NYS DOH action</td>
<td>Establish statewide collaboration process: SCP managed by the New York eHealth Collaborative (NYeC) established as forum for consensus and collaboration from all stakeholders on standards, specifications, protocols, and implementation</td>
<td>HEAL 5 AWARDS MARCH 2008 HEAL 5 funding released to grantees in advance of UPHN technical specifications</td>
<td>CHANGE IN LEADERSHIP AT NYS DOH and NYeC</td>
<td>Extend timeline: No cost extension to all HEAL-NY phase 5 grantees to allow completion of deliverables. REDUCE SCOPE of the implementation to test vs production data exchange</td>
<td>Offer common solution: open source database software allows for UPHN Web Services connection—testing and certification to proceed</td>
<td>Create test data set: Certification based on test environment. Production data not required Award non-compete bid: HEAL-NY phase 17 award to HEALTHeLINK to develop common communication layer</td>
<td>Certification received: Certification received in December 2010. First to receive certification</td>
</tr>
</tbody>
</table>

ADP, admission, discharge and transfer; DOH, NYS Department of Health; HEAL, Health Care Efficiency and Affordability Law; HIE, health information exchange; IPA, independent physician practice association; NYS, New York State; PH, public health; RHIO, regional health information organizations; SCP, statewide collaborative process; THINC, Taconic health information network and community; UPHN, universal PH node.
public health reporting use case. Selection of this use case was non-trivial as it committed each RHIO to allocate resources and demonstrate how services developed for PH reporting created value for stakeholders, in alignment with their individual missions.

Participation in SCP
The second decision point came early on, when specifications defined at a high level in the use case were under development, but not finalized by SCP. HEAL-NY phase 5 timing meant that each RHIO began their project in the absence of detailed requirement specifications. LIPIX responded with internal development of software to manage HIE services. HEALTheLINK continued reporting with PHIN-MS, a non-interoperable reporting format produced by the Centers for Disease Control and Prevention. THINC decided to build using the SCP specifications although they were not final.

Delay in specifications
The absence of agreed-upon requirement specifications continued to drive decisions. The SCP was interrupted by a number of external events, including the 2008 election, loss of leadership, and resource limitations. During 2009 and 2010, each RHIO experienced significant uncertainty, and managed the risks differently. LIPIX took a wait and see approach, preferring to risk missed contract deliverables and loss of HEAL-NY funds rather than continuing to risk internal development resources. HEALTheLINK extended role-based access to their database to local health departments, providing ongoing value to the region. HEALTheLINK transferred risk to their vendor by outsourcing management and technical development. THINC continued to develop with the unfinished specifications, risking costly rework if specifications changed.

Goal adjustment and release of open source middleware by NYS
Technical implementation was more complex, time consuming, and required a level of expertise that was greater than RHIOs, their vendors, or NYS DOH anticipated. NYS DOH responded by narrowing the scope of the use case to a test versus a production environment. NYS DOH also contracted a vendor to develop open source interface software for transmission of data packets between RHIO and NYS data servers. To provide additional time to meet contract deliverables, RHIOs were awarded 1-year no-cost extensions.

In late 2010, the software was released for RHIOs to connect to NYS DOH data servers (aka the ‘open source solution’). Each RHIO had to decide whether to link their existing information exchange environment to the open source solution, weighing the potential that adoption could limit flexibility to offer additional HIE services to stakeholders in the future. LIPIX welcomed the solution as a positive outcome to their cautious approach. Both HEALTheLINK and LIPIX built proprietary connections between the open source solution and their environment. THINC continued with development based on the SCP specifications, which offered more flexibility than the open source software for adding exchange services.

Certification process
By 2011 final deliverables were defined by NYS DOH. They called for demonstrations of data exchange based on an extensive test database, and using NYS DOH specifications. After a successful echo test each RHIO was required to respond accurately to a series of functional tests with known answers (specific patient demographic, identification, and re-identification queries, and line list queries for influenza like encounters), and to a system capability test using 100 repeated subscriptions based on a single line list query sent at intervals of 5 s. Analytical and resource queries were not tested. Success was achieved by all three RHIO and resulted in certification that use case objectives were met.

Through unmodified adoption of the open source solution, LIPIX was first to complete their contract obligations. HEALTheLINK, based on their early reporting to NYS with PHIN-MS, was awarded a non-compete contract to build a common communication layer for the SHIN-NY. Additional time spent to get that project underway meant HEALTheLINK was last to be certified. THINC accommodated the open source solution by updating their earlier build, obtained certification, and continued toward production.

Implementation
At the close of our study LIPIX had no immediate plans for production data exchange, choosing to focus on HIE activities they believed provided more value. LIPIX was subsequently subsumed in a merger of NYC metro area health information organizations. HEALTheLINK was completing the common communication layer, with production planned for late 2013. THINC was delivering live surveillance and admission, discharge and transfer from hospitals to NYS DOH using HL7 standards. THINC has come closest to substantive HIE, but we cannot attest to the value of this, because NYS is actively defining how it will use HIE for population health, focusing on public health reporting criteria stipulated in meaningful use stage 2. A major limitation of this study is our inability to assess the value of HIE beyond the capability of each RHIO to meet NYS DOH criteria for certification.

DISCUSSION
All states and territories now are engaged in HIE through US$500 million awarded through the Health Information Technology Evaluation Collaborative (HITECH) Act. Long before NYS legislators and policymakers created a landmark investment in health information technology (HIT) as a public good to improve delivery and quality of care. The changing dynamics of HIT standards, policies, and governance on both the local and national level created tremendous risk for three RHIO that were among the first to tackle HIE for public health reporting at the state-wide level. For example, during the project a change in national focus from a ‘network of networks’ to ‘DIRECT exchange’ created tremendous uncertainty for stakeholders in NYS. Nationally, the HIT community continues to strive for system equilibrium. The Office of the National Coordinator for Health Information Technology (ONC) has announced a new governance model and proposed cooperative agreements to ‘develop and adopt policies, interoperability requirements, and business practices that align with national priorities.’

Managing the disconnect between public projects and recommended HIT practice
Risk is inherent to technology implementation. Statewide or national level implementations amplify risk with a greater scale of complexity and a multi-stakeholder political landscape. Leaders of health information entities in this unstable environment must decide how to move from where they are to where they need to be, often more than once in any given implementation project. While consistent leadership and an incremental implementation approach is a preferred strategy for high-risk technology implementation, public projects
follow an established paradigm that conflicts with this approach: strict, often legislatively defined, deliverables, timelines, and funding limits, in tandem with cyclical leadership change. The conflict between the structure of public projects and the exigencies of complex technology implementation is demonstrated by this assessment. Three RHIOs relied on agile decision-making aligned with mission and vision to cope with the risk posed by a use case that initially was underspecified and over-reached what was possible given limits in time, budget, and available expertise.

The lessons demonstrated by NYS RHIOs hinge on practical vision-relevant decisions and goals, especially when short versus long-term gains and political capital were involved. For example, an unswerving vision of HIE as the future of health-care led THINC to expend significant political capital in 2009 when specifications were delayed. THINC risked alienating stakeholders, yet now is sending live production data to NYS DOH via the UPHN and its stakeholders are well positioned to meet meaningful use stage 2 criteria.

In contrast, LIPIX, with a vision focused on financial value, stalled development during uncertainty. Leadership would not entertain any threat to stakeholder investment. It was not until 2010 when NYS DOH offered open source middleware for HIE that implementation continued. While their vision differed from THINC, it provided consistent direction. LIPIX ultimately merged with several NYC RHIO into a new entity, HEALTHIX.

The HEALTHelink vision revolved around efficiencies for a tightly knit community of stakeholders. When the project stalled, HEALTHelink extended data access to local health departments. Although far from interoperable exchange, this step created value and sustained credibility during uncertainty. Perhaps more significantly, their commitment to efficiency drove their decision to outsource development. When conditions fluctuated vendor-employed staff was redeployed to other clients and resumed development quickly when project equilibrium improved.

Future of HIE in NYS
At this time the three RHIOs have business models that appear to be sustaining local HIE. The visionary HEALTH-NY capital grant program will terminate in 2013. Development of the UPHN is continuing on two fronts: modernizing NYS DOH systems with web services to enable bidirectional exchange for immunization records, new born screening, and cancer registry data, funded through ONC grants and internal public health program budgets. The second focus is on the external web services that RHIOs can deploy to accomplish statewide HIE, funded through the last phases of HEALTH-NY.

Acknowledgements
The authors are grateful for the assistance and cooperation of the three RHIO and the NYS DOH staff that participated in this study and thank them for their invaluable assistance. This study was conducted as part of HITEC (Health Information Technology Evaluation Collaborative), an academic consortium designated by the New York State as the evaluation entity for health IT projects funded under the HEALTH-NY law, a capital grant program to transform healthcare in NYS through technology and innovation. HITEC is a formal collaborative of researchers at Weill Cornell Medical College, Columbia University, the University of Rochester, and the State University of New York at Albany.

Collaborators
With the HITEC investigators, Weill Cornell Medical College.

Contributors
All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data, drafting the article or revising it critically for important intellectual content and the final approval of the version to be published.

Funding
This study was supported by the New York State Department of Health (NYS contract number C023699). ABP received support from an institutional training grant to Columbia University from the National Institute of Nursing Research (T32NR007969).

Competing interests
None.

Ethics approval
This study was approved by the Columbia University Institutional Review Board.

Provenance and peer review
Not commissioned; externally peer reviewed.

REFERENCES
1 Medicare and Medicaid Programs; Electronic Health Record Incentive Program—Stage 2; Health Information Technology: Standards, Implementation Specifications, and Certification Criteria for Electronic Health Record Technology, 2014 Edition; Revisions to the Permanent Certification Program for Health Information Technology; Final Rules, 42 CFR Parts 412, 413, and 495 (2012).
9 OSR International. 2010, NVIVO 9 (version 9).