2009

Untying the Gordian Knot: The Development of an Immunization Information Exchange

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ABSTRACT

Legislative mandates require the sharing of immunization information among multiple stakeholders. This in turn requires the implementation of interoperable systems across various information systems. A key challenge to system interoperability is the need to integrate healthcare information and processes across different settings. This paper reports work in progress on the development of a student immunization Health Information Exchange (HIE). The system builds on a commercially available platform, appropriately modified on both front and backend, to meet the needs of school health professionals and other stakeholders involved in the production and maintenance of immunization information. We describe the situated change perspective as well as the iterative and incremental development process adopted for the project, and examine some of the lessons learned throughout.

Keywords

Immunization records, schools, interoperability, information exchange

INTRODUCTION

Timely and methodical vaccination against contagious diseases constitutes a cornerstone of public health in contemporary societies. For immunization to be most effective, 95% of children and adolescents must be currently immunized. In the U.S., public health officials recommend and physicians provide immunizations but compliance with immunization mandates in all states falls to public school officials (Orenstein & Hinman, 1999). School corporations are required to provide notification and immunization information to parents, to seek statements of immunization history, to ensure each student's immunization

status meets current requirements, to maintain immunization records, and to self-report student immunization coverage levels to the State Department of Health (SDH). While essential to public health, this mandate places a substantial burden on schools partly because current paper-based systems are very inefficient at sharing information among school administration systems, health care practice management systems, electronic health records, and state immunization registries. Computerization of record exchange and standardized student health information, including immunization records, can improve this situation to a great extent. However, school corporations typically do not have the resources to develop such systems and until recently, the absence of a national standard for health information posed a substantial barrier towards that goal.

This paper reports work in progress on the development of a student immunization Health Information Exchange (HIE) with the pseudonym HIEX. The development process started with a comprehensive study of the current information flows among stakeholders, leading to a set of requirements, which were then analyzed for the purpose of improving the workflow. The constraints discovered during the analysis gave rise to issues and problems that had to be met through an incremental and iterative design process. The "situated change" perspective introduced by Orlikowski (1995) provided the theoretical lens in the analysis and conduct of this project. In what follows, we outline these steps, and highlight some of the key lessons that were learned throughout this process.

CURRENT WORKFLOW AND ITS PROBLEMS

The current flow of immunization information includes four entities: the school corporation, the state, practitioners, and families. Each entity currently has its own computerized or paper-based information system (see Figure 1):

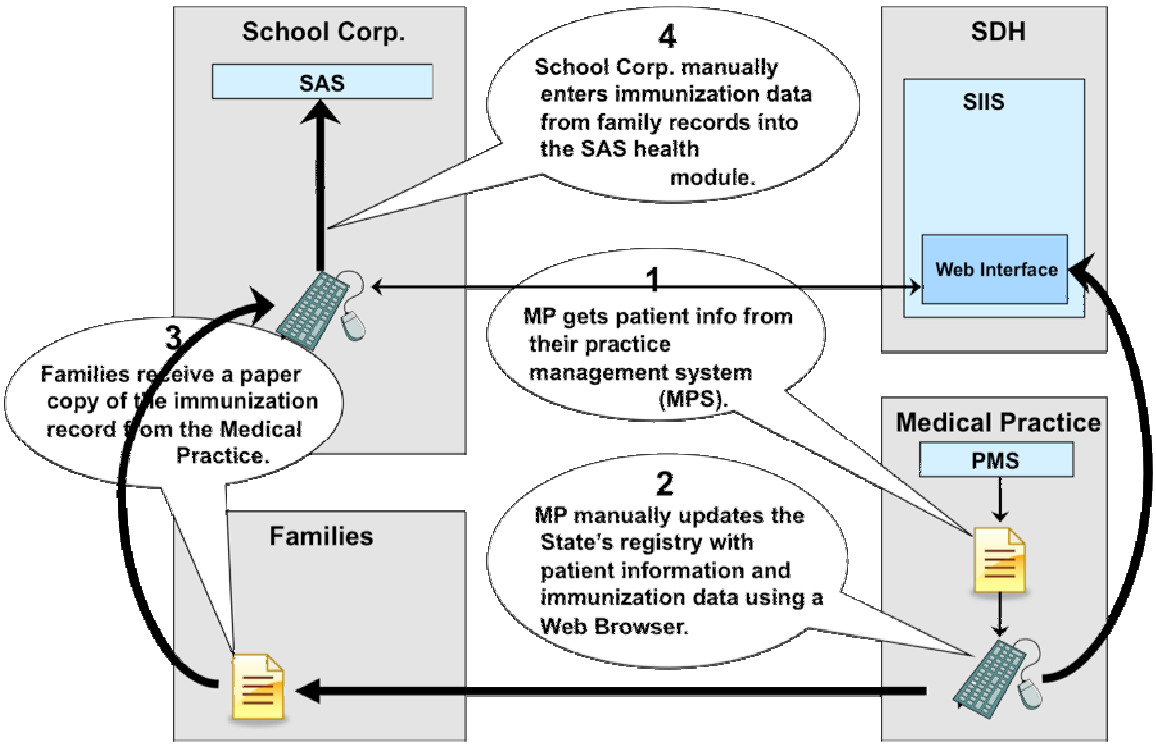

Figure 1. Current immunization data flow (The keyboard represents manual entry of information, and line thickness represents the intensity of data flow.)

1. The School Administration System (SAS): This system is for managing school operations such as student academic records, finance, social services, etc. SAS includes a health module with limited medical records functionality – it lacks standard medical nomenclatures, reporting standards, etc. The system's vendor offers an interoperability framework, but the school corporation currently does not own that module. The school health personnel have web-based access to the state registry, but need to query and update individual student records manually – an time-consuming and error-prone process.

2. The Practice Management System (PMS): Medical practitioners similarly have a proprietary practice management system used for daily operations (i.e., demographics maintenance, appointment scheduling, and billing). Some practitioners will also have a clinical system to manage medical records. In addition, they have access to the state immunization registry, which they use to make individualized queries and updates of immunization information. However, they have to manually re-enter patient demographic information because their practice management system does not link to the state registry.

3. The State Immunization Information System (SIIS): The State Department of Health enforces the immunization mandate using a statewide immunization registry – the SIIS. Its current centralized registry supports an external data interface from the CDC based on the HL7 standard (DHHS 2006; Bazzoli 2007). Nationally, there is an initiative to develop a more comprehensive standard for immunization data exchange that would support exchange with personal health records (PHRs) using the federally approved Continuity of Care Document (CDC).

4. The Families: Students and their parents are the intermediaries between medical practitioners and the school system, but they currently have no electronic access to immunization information.

As the above summary illustrates, the current flow of information manifests many interrelated problems and potential flaws such as the following (see Figure 2):

- *Redundancy*: There is a great deal of redundancy in manual data entry into various systems;
- *Inefficiencies*: the overall process involves time-consuming manual practices;
- *Errors*: multiple data entry points increase the probability of errors;
- *Staffing*: There are periods of "surge" in activity at both the schools and medical practices at certain times during the year, with consequent staffing problems (and a potential increase in errors);
- *Breakdowns*: The cumulative effect of the above is frequent system breakdowns in the shape of information updating, mismatch, and resolution, which sometimes lead to unwarranted banishment of students from school;
- *Exclusion*: The families are by and large excluded from the implementation process, their role being reduced to intermediaries, despite the fact that they are somehow the key stakeholders in the whole process – a fact that works against current trends towards patient-centered healthcare (Lee and Lansky 2008);
- *Health Risks*: Last but not least, the overall impact of these is the potential of serious lapses in the implementation of immunization mandates, posing eminent risks to the public – as evidenced by recent reports of recurrent contagious diseases around the globe (UNOCHA 2008).

Given these and other potential issues, computerization of the activities and processes seems to strongly suggest itself as the solution. However, the intertwined character of these problems, and their close link with broader socio-economic issues, calls for a cautious, measured, and incremental approach to design. We next discuss the approach adopted in our design, and the decisions that were made thus far, to deal with the above problems.

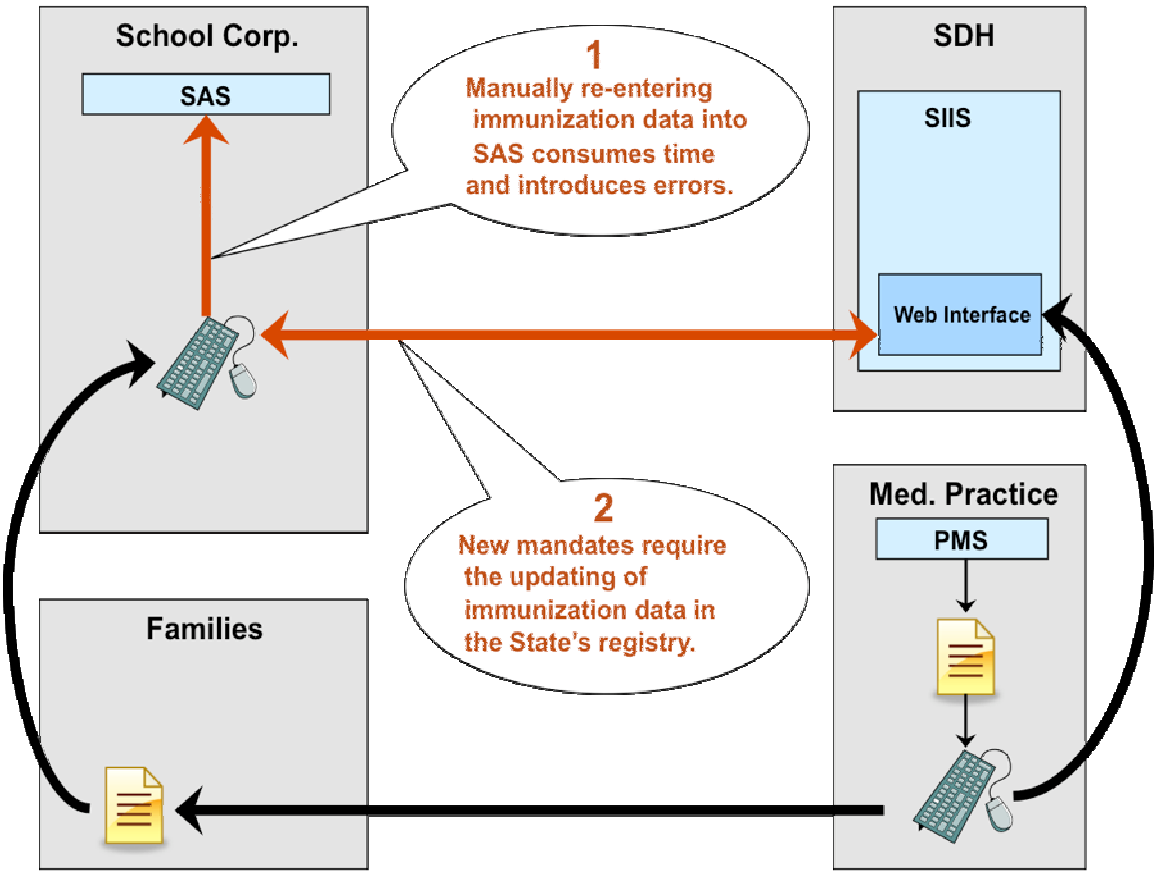

Figure 2: Some of the problems in the current workflow.

DESIGN PRINCIPLES AND THEIR IMPLICATIONS

Our team, which consists of health, information technology, and human-computer interaction practitioners, approached these problems with a number of principles in mind. Like any other design activity, some of these principles were explicitly followed, while others were discovered, adapted, and developed during the study. Here we discuss some of the key principles that guided our design -- namely:

- *Situated View*
- *Socio-technical Approach*
- *Incremental Design*
- *Iterative Process*
- *Interoperability*
- *Public-Private Partnership*

In what follows, we introduce these design principles, and draw some design implications from them.

Situated View

We adopted a situated view to the overall project, in the sense of understanding technology in the context of its use (Blomberg et al. 1993). The situated view has both conceptual and methodological aspects. Conceptually, it calls out attention to the flexible interpretability of technology, the various meanings that different user groups may attribute to the same technology, and the creative ways that they employ in confronting an artifact. Methodologically, it suggests the close study of work practices in the context of their happening (Simonsen and Kensing 1997). More specifically, in dealing with organizational transformations of the kind encountered in the current project, the situated view provides a view of change as improvised, emergent, and incremental, "not as a drama staged by deliberate directors with predefined scripts and choreographed moves, or the inevitable outcome of a technological logic, or a sudden discontinuity that fundamentally invalidates the status quo" (Orlikowski 1996).

1. *Design Implication: Stakeholder Buy-in*. The formative part of our project mainly consisted of on-site visits to the School Corp. and medical practitioner office, where most of the activities relating to vaccination take place. Through these visits, we achieved a close understanding of the work and information flows, the current technologies, the problems and bottlenecks, and so on. It was only through these understandings that the team could attain strong stakeholder buy-in.

2. *Design Implication: Continuity in Interface Design*. The same software platform used in two different contexts or work environments – e.g., a practitioner office versus a school – needs different interface designs in order to be effectively utilized. As we said, the current SAS software used by the school corporation has a health module with an interface customized for school nurses and office clerks. While there might be some flaws with the interface, the new design cannot deviate drastically from it, as that might steepen the learning curve and generate unexpected interruptions in the workflow.

Socio-technical Approach

As mentioned earlier, the current situation in the sharing of immunization records can certainly benefit from computerization for the reasons that we have alluded to above. Reduction in errors and redundancies, enhanced efficiency, fewer breakdowns, and more informed families are some of the sought-for outcomes of computerization. However, none of these outcomes could be taken for granted. Experience has shown time and again that computerization constitutes a socio-technical intervention, rather than a simple technological change.

3. *Design Implication: Privacy Solution*. Throughout the study, we learned that identification and privacy play a central role in information sharing practices. As such, a solution to privacy concerns should be part and parcel of any computerization initiative. One approach to this would be to give various levels of access and privilege to different users and stakeholders. The use of composite keys for databases might be part of this, but it is not the whole solution

because access privileges and database keys do not always align. As such, the design should seek more creative, and perhaps more sophisticated, schemes for dealing with privacy.

Incremental Design

Student health information involves more than vaccination information. It includes, for instance, information about allergies, medications, physical activity, mental health, and so on. A comprehensive project for sharing the whole gamut of health information should be, therefore, capable to process all of this. In addition, the current trend towards patient-centered healthcare demands the inclusion of Personal Health Records (PHRs) in the system. To incorporate all of these in the initial design, however, will overburden the design team, and it may also intimidate other players.

4. *Design Implication: Limited Objectives*. The design team initially considered the inclusion of all types of health information in the project, but resource considerations led us to narrow our objectives to the most urgent and most common issue – namely, immunization information. This kind of incremental approach would allow us to gradually add other components to the system, and at the same time not lose sight of further additions and objectives.

Iterative Process

Design is *not* a one-shot process; rather it has to go through multiple cycles where outcomes are measured against goals and objectives. In our approach, this would consist of many rounds of design and evaluation with the close participation of various users.

5. *Design Implication: Prototyping*. The design process would involve the development, testing, and improvement of multiple prototypes that will be built in close collaboration with school nurses and health aides. Ideally, IT staff of the School Corp., as the final administrators of the system, will be also closely involved in the development of the prototypes.

Interoperability

As we have seen, multiple stakeholders with multiple information systems and practices are involved in the sharing of immunization information, highlighting interoperability as a main objective of the project. However, here as elsewhere, interoperability takes a much broader meaning than the narrow technical sense sometimes implied by the term. Many organizational, political, and economic barriers need to be overcome for full interoperability. The provisions of the Continuity of Care Document (CCD) and HL7, as the emerging and generally-accepted standards of the field, is a good first step in this direction, but it is by no means the whole story.

6. *Design Implication: Multi-Objective Optimization*. Multi-criteria optimization techniques can be applied to simultaneously optimize the objectives of different stakeholders. The goal of such techniques in this project would be to answer, for instance, how to (i) maximize the efficiency of vaccination system, (ii) minimize the cost and time needed for efficient vaccination, (iii) maximize stakeholder satisfaction, and (iv) minimize the health risk behaviors that lead to particular diseases.

Public-Private Partnership

Despite its seemingly narrow focus, an immunization information exchange system that would meet all the requirements set out for the current project needs a platform with multiple features, functionalities, and standards. Given that few commercial platforms are available with many of these features it would seem reasonable to employ, modify, and enhance them rather than develop software from scratch.

7. *Design Implication: Business Model*. Using commercially available software in such a way that it could support research activity in health, information technology, and other areas is a challenging undertaking that could be met through creative partnerships and business models. Such joint ventures should consider, among other things, the issues of intellectual property rights, licensing, data ownership, privacy, and profit sharing between research institutions and for-profit software vendors. It should also pay attention to the potentials of free/open source software. Design teams cannot divorce their activities from such major considerations. At this point in our project, we have not been able to articulate these, but we are well aware of their significance in the long run.

CONCLUSION

Vaccinations are an essential component of public health, and schools are key players in monitoring and complying legislative mandates on immunization. More broadly, school-based health care may provide solutions to some of the most enduring problems in public health (e.g., obesity and diabetes), and can thus play a larger role in policy conversations in the future (Graham Lear et al. 2008). Any system that can help schools perform this role and improve their performance could potentially make a remarkable impact on public health.

Here we have reported preliminary steps in the design of such a system. Due to the inherent social, organizational, and technical complexity of the issues, we have adopted a broad but cautious approach to design. Aware of the challenges and wary of magical thinking in health IT (Diamond and Shirky 2008), we are optimistic that our situated approach and incremental method will bear fruitful results. In addition to practical issues such as interoperability, data handling, and business model, privacy remains a major pressing concern to be dealt with, as in almost all other health-related projects (GAO 2007). In line with our situated approach, we believe that workable solutions to issues of privacy should emerge from the close involvement of the primary stakeholders – in this case, students and their families – in the process. We intend to pursue this by incorporating a PHR component to the system in the future stages of the project (see Figure 3).

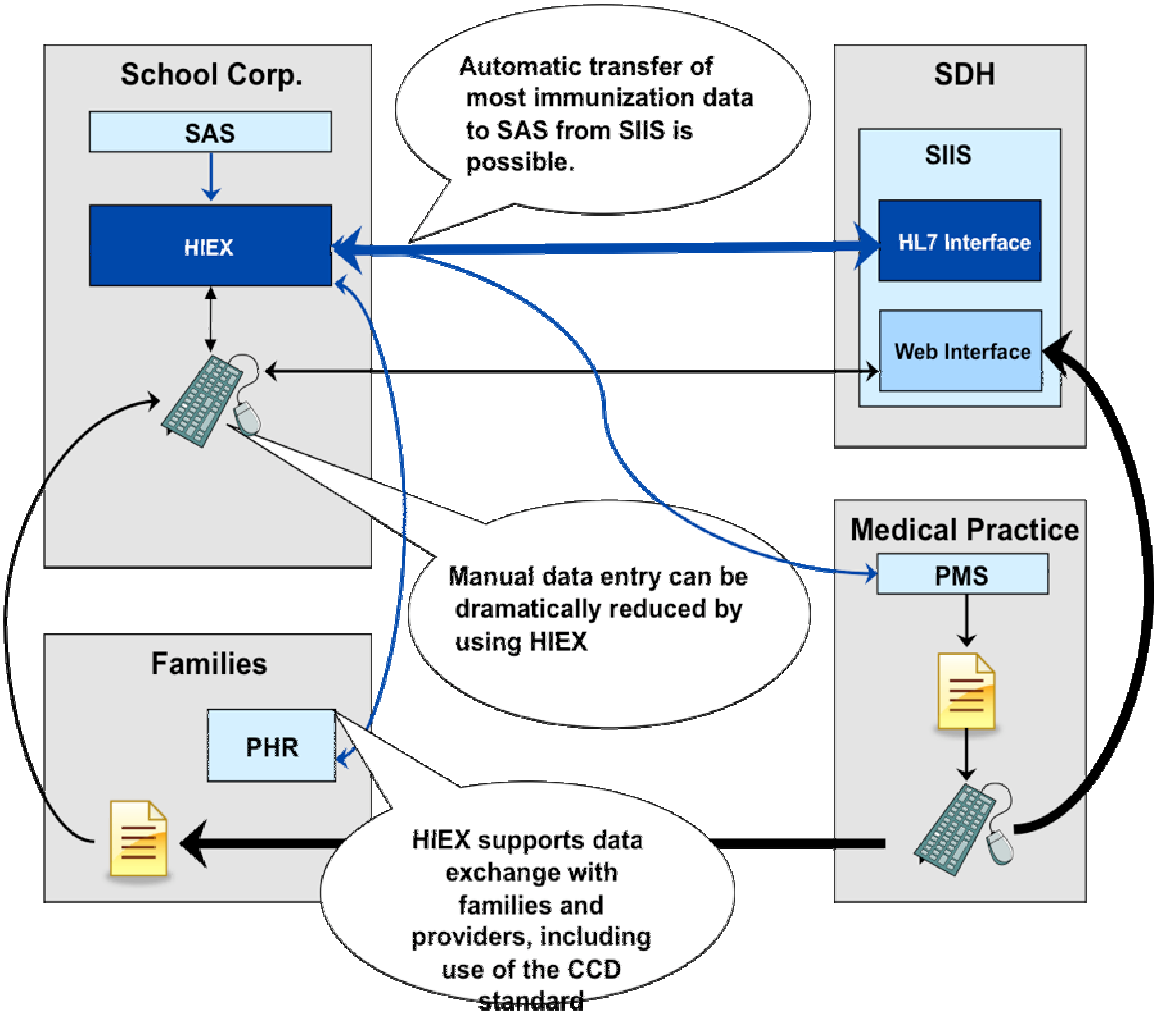

Figure 3. Future functions and expansions of HIEX

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