Designing for Adoption: A Living Laboratory for Health IT

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Abstract
We describe how an interdisciplinary collaboration has created a "living laboratory" in which researchers maintain a direct and ongoing loop between innovation and production and study true adoption of technology in real world settings. The collaborators include the Department of Biomedical Informatics and the Department of Computer Science at Columbia University, industrial partners developing commercial health IT applications, and New York-Presbyterian Hospital's Columbia University Medical Center. In this paper we discuss our current projects, and mention some of the unique benefits and challenges of building a living laboratory for health information technology.

Keywords
Health information technology, living laboratory, design, evaluation

ACM Classification Keywords
J.3 Life and Medical Sciences: Medical Information Systems.

General Terms
Design

Introduction

The health care industry maintains tight connections with research communities in such areas such as Computer Science (CS), Human-Computer Interaction (HCI), and Biomedical Informatics, among many others. Traditionally, researchers investigate problems experienced by health care professionals and identify opportunities to enhance work practices with novel technologies. Oftentimes, especially in the field of HCI, researchers work with potential users of new technologies through formative studies, user-centered design approaches and evaluation studies, often leading to prototypes. Occasionally, these prototypes inspire new commercial products that are adopted by health care professionals and shape the way health care is delivered. In many cases, however, the engagement of research does not extend beyond the initial investigation and prototyping phases, and opportunities to study adoption of innovations and incorporate lessons learned into the design of new technologies are limited.

In contrast to this approach, the New York-Presbyterian (NYP) Hospital's Columbia University Medical Center, jointly with the Department of Biomedical Informatics and the Department of Computer Science, have cultivated a "living laboratory" environment in which technological innovations can be deployed for use in real clinical settings. Throughout the years, these innovations included complete Electronic Health Record (EHR) systems for the hospital and a number of novel applications that have enhanced commercial health information technology (IT) applications used by the hospital [2].

Current Collaborative Projects

We are applying our experience with system integration, patient-centered design, computerized provider order entry, and electronic documentation to design clinical innovations focusing on quality, safety, and effectiveness. Below, we outline current projects on which we are collaborating.

Including patients and their loved ones as part of the inpatient care team.

This project focuses on the design of patient-centered, bedside information technology, linking the inpatient EHR with the hospital's personal health record (PHR) system. We build on previous work on collaborative communication among the care team, including studies of patient handoff, goal-setting, and task coordination to answer the question: how can we include patients and their family members in the care team?

Achieving effective medication reconciliation across care settings.

We are conducting a formal study of the paperless medication reconciliation process at NYP that uses a medication list based on discrete, coded elements to bridge ambulatory and inpatient care settings.

Improving electronic documentation tools and assessing their use.

We are currently evaluating the impact of electronic documentation at NYP (over 100,000 clinical notes are entered each month into the EHR). Through commercial systems that we have augmented and deployed [6], and research prototypes used in design explorations [7], we are investigating new approaches to information retrieval for documentation and content management. We are beginning to answer questions such as: How can technology enable relevant information retrieval from unstructured documents? How can technology better enable clinical notes to serve as effective communication artifacts?

Extending the reach of the EHR using mobile devices to support task management for clinicians.

For this project, we are developing technology to support the delivery of subscriptions to messages originating in the EHR (e.g., laboratory results and task reminders) to care team members, via mobile devices such as the Apple iPhone. This project explores questions such as: how can mobile technologies better enable care team members to coordinate tasks and share information? What types of interaction and presentation techniques can permit clinicians to view and manage notifications and alerts in the context of care delivery?

Our particular approaches to these and former projects point to a number of unique benefits for the researchers in HCI, CS, Biomedical Informatics and related fields. However, they also face a number of challenges. Next, we discuss these challenges in the context of design, implementation, and evaluation of technology. The list presented here is far from exhaustive; our hope is to highlight some salient points that could inspire a discussion within the community.

Design Challenges

Health and medical care are extremely expertise-heavy domains. Medical professionals undergo years of intensive training and continue to refine their expertise throughout their practice. This limits the designers' ability to become domain experts. At the same time, medical professionals are some of the busiest people, leaving little opportunity for traditional user-centered design processes, such as interviews, observations, and participatory design [1,5]. These challenges present a need for different approaches to engaging users in research and design. We found that short but intense feedback sessions (e.g., 30 minutes [7]) can save clinicians' time and provide sufficient information to inform ongoing research and design. We also found that it was effective to include a feedback mechanism to capture clinician feedback, not as a bug reporting utility or service function, but as a way to record frustrations and ideas for improvement.

Practicing medicine as part of a living laboratory often leads to cautious attitudes to novel designs and solutions. This presents a need to balance innovation and familiarity and places particular importance on achieving the right tradeoff between longer-term benefits and immediate adoption costs. Also, new technologies require adjustments to work practices that could lead to initial inefficiencies. This is especially true in cases when new technology initially co-exists with older technology rather than replacing it, which often leads to duplication of work.

Modern medicine relies heavily on computing technology. The information technology presents a complex ecosystem of infrastructures and applications designed for interdisciplinary teams, as well as individual clinicians. Each new application needs to be designed with respect to this ecology and each new design needs to be considered in context of its implications for the overall system.

Implementation Challenges

Information technology in health care industry is slow to change. Many clinical centers, small and large, continue using outdated technology, often decades after its prime. Novel technologies typically need to be integrated with legacy applications, infrastructures, data storage and communication standards.

Health care is an intensely regulated industry, with various standards controlling many aspects of care itself, as well as information technology supporting care practices. Controlled vocabularies, information exchange protocols and data structures are a necessary component for each new application.

The existing ecology of computing systems and infrastructures impacts both implementation and design of new applications. Each new innovation needs to co-exist with existing systems.

Evaluation Challenges

The living laboratory presents an opportunity to go beyond usability studies and small-scale deployment studies to study true adoption (or lack thereof) of computing technologies. At the same time, it presents a need for new metrics for evaluating the long-term impact of technology and its adoption by users. This integrated view of a computing system as an ecology makes it difficult to separate the effectiveness of its components.

The complex and mission-critical nature of health care settings makes it difficult to run rigorous controlled experiments. Often, researchers have limited impact on the consistency of usage, or it is hard to isolate and control variables; In these cases, it may be impossible or impractical to include a control condition. Moreover, clinical tasks are often interdependent and not clearly defined, further complicating experimental design.

Any health care IT should be evaluated on clinical outcomes, such as improved quality of care or on improved efficiency and cost-saving. However, these measures require extensive longitudinal studies, presenting the need to introduce intermediate outcomes. For example, for applications specifically targeting improved clinical documentation, there are no existing gold standards that could be used for comparison. One approach is to invite experts to judge the quality of work mediated by novel technology [3]; however these approaches tend to be costly and time-consuming.

Finally, the years of collective expertise in conducting usability studies has allowed the HCI community to formulate a number of heuristics that allow experts to predict usability of computing systems with a certain level of confidence [4]. There is a need for a set of heuristics that can allow experts to anticipate the likelihood of adoption of computing systems. Longitudinal studies of health IT adoption, which are possible in living laboratories, should make it possible to formulate such heuristics.

Conclusions

In this paper, we discussed some of our current collaborative projects, and our experiences designing novel computing technologies that support clinical work in a living laboratory. We also discuss some key challenges associated with conducting research in this unique setting.

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