Case Report

Diffusion, implementation, and use of Research Electronic Data Capture (REDCap) in the Veterans Health Administration (VA)

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ABSTRACT

This case study describes the implementation of the Research Electronic Data Capture (REDCap) software at the United States Department of Veterans Affairs Veterans Health Administration (VA). VA REDCap enables secure and standardized data collection, fosters collaboration with external researchers through use of a widely used data management tool, facilitates multisite studies through use of data forms that can be shared across sites within and outside the VA, is well suited to health services research studies and quality improvement projects, and enables exporting data for analysis in the VA secure computing environment. Using a diffusion of innovation framework approach, authors explore organizational factors that shaped adoption of REDCap technology and constraints on its use within the VA. Lessons learned from the VA experience are discussed.

Key words: organizational innovation, health services research, data collection

INTRODUCTION

The Research Electronic Data Capture (REDCap) software was developed at Vanderbilt University to address data collection needs of health system researchers and has been widely adopted. The Veterans Health Administration (VA) is the largest integrated healthcare system in the United States, has an established intramural health services research program, and primary data collection software is vital to support research.

The VA Information Resource Center (VIReC) convened an interdisciplinary team with members from key VA information technology offices, research stakeholders, and affiliated university subject matter experts to develop a VA REDCap pilot. The implementation of VA REDCap is presented as an example of an innovation spreading within a large organization.

IMPLEMENTATION

The adoption of REDCap in the VA was a complex process. We use the Greenhalgh Diffusion, Dissemination and Implementation Conceptual Model to describe this process and the contributing factors and components. The Greenhalgh model includes factors related to outer context, the innovation itself and approach to spreading the innovation, organizational context, the individual adopting an innovation, and linkages between these factors. Table 1 highlights con-
VA policies shaped the implementation of VA REDCap. REDCap is required to be configured as an intranet application. This means that some of the functionality expected from a REDCap system is not possible in VA REDCap, such as having people using a computer outside the VA firewall complete a survey. This is an example of a linkage between the outer context and the innovation, as the conditions for use had a direct impact on the functionality of the system.

Innovation and spread

The REDCap software was innovative in its own right; and even with the limitations, it was vastly superior to other options available to VA researchers at the time. In VA research prior to 2013, the most common software in use for primary data collections included Microsoft Access®, SAS®, and optical scan forms. Although REDCap was implemented locally by several VA medical centers, its use was not widespread. VA investigators involved in National Institutes for Health (NIH) Clinical Translational Science Award (CTSA) work formed a technical special interest group (TSIG) and advocated for VA REDCap as a tool to support shared data collection templates and multisite studies. The implementation of VA REDCap as an enterprise-wide system streamlined both the research process and the organizational resources needed to support the system.

Key attributes of an innovation include relative advantage, compatibility, trialability, observability, and adaptability. VA REDCap was superior to other programs in use at the time. Participation in the REDCap Consortium and relationships with university affiliates helped to make the benefits of VA REDCap visible to potential users. However, a challenge of implementation was clarifying VA REDCap functionality and managing user expectations.

Although there were constraints on the configuration and use of VA REDCap, there was flexibility in the “organizational structures and systems required for the full implementation of the innovation” as shown by the development of the VIReC VA REDCap Support Team. This is what is meant by “soft boundaries,” the organizational adaptations that help the innovation fit within the larger organizational context in a complex service organization.

The development and adaptation of the Support Team is also an example of a linkage at the design stage, as the team has a key role in supporting the user system. The beta test was conducted October 2013 to January 2014, and the pilot was expanded each year until the system became available to all VA employees in FY16. In 2018, the VA REDCap system received formal approval as a VA enterprise software application. Until that point, VA REDCap was considered a pilot project. Growth of the VA REDCap user base is shown in Figure 1. The Support Team works to increase user autonomy and satisfaction by streamlining procedures and providing education and one-on-one support to users. In 2018, VIReC addressed 2083 requests with 99% (N = 704) rating overall customer service as excellent or above average.

The spread of the innovation is the process by which it is adopted by people across the organization, and approaches to spread can range from “let it happen” (diffusion) to “make it happen” (dissemination). The spread approach for VA REDCap was to “help it happen” and had elements of both diffusion and dissemination.

Software implementation at the VA cannot be done by diffusion alone, as software needs to be approved, installed, managed, and used in compliance with VA policy. The project team built the infrastructure, making VA REDCap available. In use at 155 of the

| Concept | Descriptions |
|---------|--------------|
| Outer context | Sociopolitical climate, incentives and mandates, interorganizational norm-setting, environmental stability |
| Innovation and spread | Innovation: Relative advantage, compatibility, low complexity, trialability, observability, potential for reinvention, fuzzy boundaries, risk, task issues, nature of knowledge required, and technical support Spread: Viewed as a continuum from diffusions that is informal, unplanned to dissemination which is formal and planned |
| Organizational factors | Resource system: Organizational resources available to support implementation, including relationships with external subject matter experts Knowledge purveyors: Networks of individuals within the organization that may help to spread the innovation Change agency: Readiness and capacity to change |
| User system | System antecedents: Structure, absorptive capacity for new knowledge, receptive context for change System readiness: Tension for change, innovation system fit, power balances, assessment of implications, dedicated time and resources, monitoring and feedback Adoption/assimilation: Individual needs, motivation, values and goals, skills, learning style, social networks; complex nonlinear organizational process, soft periphery elements Implementation: Decision-making devolved to frontline teams, hands-on approach by leaders, human resource issues, training, dedicated resources, internal communication, external collaboration, reinvention/ development, feedback on progress Consequences: Evaluation of impact of adoption of the innovation |

ceptual model components. A strength of the Greenhalgh model is that it considers that factors may interact to produce an effect on the decision to adopt and the success of implementation.

Outer context

The outer context includes factors related to mandates, interorganizational norm-setting, and environmental stability. Many VA investigators maintain academic affiliations, and as many universities implemented REDCap software, researchers became accustomed to its use. There was increasing demand for research to be more efficient and use standardized approaches. REDCap was informally recommended as a secure, common solution to data collection needs by the VA Office of Inspector General (OIG), the VA legal department, in 2010 to protect against data loss and breaches from use of paper and portable data storage devices. Although an informal recommendation from the OIG is not a legal mandate, the OIG recommendation contributed to the decision to implement VA REDCap.

Table 1. Greenhalgh conceptual model components

| Concept | Descriptions |
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| Outer context | Sociopolitical climate, incentives and mandates, interorganizational norm-setting, environmental stability |
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168 VA medical centers (92%), VA REDCap has been widely adopted across the enterprise.

Organizational factors
The resource system includes organizational resources used to support adoption of the innovation, and an organization with people spanning organizational boundaries to provide subject matter expertise is more likely to be successful. The VA supported the implementation of VA REDCap, making resources from various departments available. The VA also leveraged its relationships with the REDCap Consortium and university affiliates to bolster knowledge about the REDCap system and considerations for implementation.

Knowledge purveyors contribute to the passive diffusion of the innovation. Similar to how boundary-spanning subject matter experts support implementation at the organizational level, knowledge purveyors spread information about the innovation through their social networks. Networking groups for VA researchers such as the CTSA-TSIG provided an infrastructure for individuals to share experiences of using REDCap systems.

Change agency concerns the capacity of the organization to make the changes necessary to adopt the innovation. The focus of the CTSA-TSIG on adopting REDCap at the VA and the recommendations of the OIG contributed to a tension for change, leading to the VA REDCap project.

User system
Innovations are adopted (or not) by individuals within an organization. The user system factors include organizational factors (system antecedents and system readiness), individual factors related to the decision to adopt ( adoption/assimilation), the implementation itself, and consequences of adoption.
Organizational factors that are part of the user system were previously discussed, but it is also important to consider the user perspective. Prior to implementation of VA REDCap, there were some local instances of REDCap software. However, this approach was limited in scope and placed a burden on local resources. Without successful implementation of VA REDCap as a central resource, it would not be possible for researchers across the VA to adopt its use. The support provided by VIREC to users is also an important piece of the VA REDCap implementation puzzle, as it helped the VA REDCap system fit into the larger organizational context.

Users also have individual characteristics that affect the decision to adopt, and there is an individual implementation process that takes place for new users. Each user must learn how to use the system, both the mechanics of using the software and how its use fits within the larger context of the study protocol. Existing users of REDCap systems outside the VA may be more likely to use VA REDCap, as they already have experience with the software, may have benefitted from using the system in the past, and are able to use established data collection project structures. Use by an individual may be influenced by peer adoption and whether the functionality of the system adequately supports the planned data collection approach.

Consequences of using VA REDCap for an individual researcher may vary. Shifting from paper data collection to electronic data capture makes data entry efficient, reduces risk of data loss and breaches, improves data quality, and makes it easier to replicate studies. Now that the VA REDCap system is commonly used across the VA, new users of the system have a different organizational context than the pilot participants.

Linkages between factors
Understanding factors of the outer context, innovation and spread, organizational factors, and the user system contribute to an understanding of the adoption of the innovation. However, these factors do not exist in isolation, and it is important to understand how the factors relate to each other. For example, organizational factors regarding how technology is deployed within the VA affected how the software was configured and the conditions for its use, comprising the innovation itself. Figure 2 shows these factors mapped onto the Greenhalgh model, demonstrating the relationships between factors over time.

DISCUSSION
Researchers have made use of VA REDCap despite its limitations. When an existing research data collection tool includes identifying data, the tool is modified for use in VA REDCap to remove the identifying data and the researcher works with the local Information Security Officer (ISO) on an appropriate solution for storing the identifying data. Also, researchers have used computer equipment from inside the VA firewall to collect data from study participants electronically.

A lesson from the VA REDCap implementation that applies more broadly is that how a system is deployed and how it can be used at a particular institution is intertwined. Governance and policy decisions shape the organizational context and, in turn, the local context. In the case of VA REDCap, the configuration of the system as an intranet application and restrictions on use of identifying data were a direct result of governance and policy decisions. Some organizations have mitigated concerns about data security by using two instances of REDCap, one that is public facing but excludes identifying data and another that is an intranet application but allows identifying data. Although decision constraints may not be negotiable within a particular institution, from a broader perspective they can be seen as variable factors that influence the adoption of the innovation.

There are benefits and disadvantages to the approach taken to implement VA REDCap. A critical disadvantage to our approach of “help make it happen” with a prolonged pilot period is that there was uncertainty for researchers in planning new projects, as the continued maintenance of the system was unclear. Researchers had to make contingency plans for their data collection, which made projects less efficient. However, a benefit of the approach taken was that the VA REDCap system was made available to as many researchers as possible, incrementally over time, providing a valuable resource at relatively little cost. Researchers and quality improvement project teams have come to depend on VA REDCap as a secure primary data collection tool to support their critical work. The slow and steady approach to expansion also provided time for the Support Team to adapt and provide education and services more efficiently and effectively.

CONCLUSION
The Greenhalgh model provided a useful framework to understand the adoption and diffusion of REDCap across the VA. Use of the model helped to understand different factors and interactions between factors that influenced the adoption of VA REDCap. The implementation of VA REDCap demonstrated that the local context is important, shapes the implementation and utility of the system, and that the “help make it happen” approach can be successful. These experiences may serve as a roadmap for future implementations of REDCap systems, even though each implementation explores new territory.

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