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Research Paper

User-centered design to improve clinical decision support in primary care

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ABSTRACT

Background: A growing literature has demonstrated the ability of user-centered design to make clinical decision support systems more effective and easier to use. However, studies of user-centered design have rarely examined more than a handful of sites at a time, and have frequently neglected the implementation climate and organizational resources that influence clinical decision support. The inclusion of such factors was identified by a systematic review as "the most important improvement that can be made in health IT evaluations."

Objectives: (1) Identify the prevalence of four user-centered design practices at United States Veterans Affairs (VA) primary care clinics and assess the perceived utility of clinical decision support at those clinics; (2) Evaluate the association between those user-centered design practices and the perceived utility of clinical decision support.

Methods: We analyzed clinic-level survey data collected in 2006–2007 from 170 VA primary care clinics. We examined four user-centered design practices: 1) pilot testing, 2) provider satisfaction assessment, 3) formal usability assessment, and 4) analysis of impact on performance improvement. We used a regression model to evaluate the association between user-centered design practices and the perceived utility of clinical decision support, while accounting for other important factors at those clinics, including implementation climate, available resources, and structural characteristics. We also examined associations separately at community-based clinics and at hospital-based clinics.

Results: User-centered design practices for clinical decision support varied across clinics: 74% conducted pilot testing, 62% conducted provider satisfaction assessment, 36% conducted a formal usability assessment, and 79% conducted an analysis of impact on performance improvement. Overall perceived utility of clinical decision support was high, with a mean rating of 4.17 (± .67) out of 5 on a composite measure. "Analysis of impact on performance improvement" was the only user-centered design practice significantly associated with perceived utility of clinical decision support, b = .47 (p < .001). This association was present in hospital-based clinics, b = .34 (p < .05), but was stronger at community-based clinics, b = .61 (p < .001).

Conclusions: Our findings are highly supportive of the practice of analyzing the impact of clinical decision support on performance metrics. This was the most common user-centered design practice in our study, and was the practice associated with higher perceived utility of clinical decision support. This practice may be particularly helpful at community-based clinics, which are typically less connected to VA medical center resources.

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1. Introduction

1.1. Background

User-centered design draws on cognitive science, psychology, and computer science to make information systems more useful and easier to use [1]. Though user-centered design has been applied to a range of clinical and operational processes, researchers have found it particularly relevant to clinical decision support (CDS), the tools that make evidence-based medical knowledge accessible and salient [2]. There are good reasons for this: CDS can be highly effective, but there is substantial variability in the usability, efficacy, and even safety of CDS [3–6], and user-centered design offers a way to identify and respond to these potential deficiencies [7].

A growing body of literature on user-centered design has helped to disseminate and refine user-centered design practices and has uncovered important lessons about the application of user-centered design in a clinical context [8]. This research often takes the form of papers that propose new approaches to user-centered design or that describe the application of these approaches in a clinical setting. However, user-centered design in these studies has often been directed or heavily influenced by informatics researchers. This involvement increases the possibility that results may differ in settings that do not benefit from the expertise and regular participation of experts in informatics whose work is frequently supported by a research grant. In addition, most studies on user-centered design of clinical decision support have necessarily been conducted within an individual clinical site or a small network of sites [9]. There remains an opportunity to study user-centered design across many sites with different users, different structural characteristics, and different resources, policies, and challenges. These contextual factors have been underexplored not only in studies of user-centered design but in studies of health IT in general, with one systematic review noting that “the most important improvement that can be made in health IT evaluations is increased measurement, analysis, and reporting of the effects of contextual and implementation factors.”[10]

In this study, we seek to fill these gaps in the literature by analyzing national survey data from a 2006–2007 census of US Veterans Affairs (VA)[1] health care facilities with large primary care caseloads. The survey data provide information about user-centered design practices and the perceived utility of CDS.

We examine user-centered design practices through the lens of organizational behavior and implementation science, and this lens informs the type of outcome we evaluate and the types of contextual information we consider. We analyze reports of CDS utility from the primary care director at each clinic. In VA health systems, the primary care director is responsible for supporting population health and evidence-based decision-making across the clinic. These reports represent a unique perspective focused on organizational priorities. We also account for clinics' resources, implementation climate, and structural characteristics − factors that are routinely incorporated in organizational behavior studies, but are rarely represented in studies of user-centered design. We take advantage of the variability in clinical practice and organizational strategies within the VA [11] which provides study sites that are comparable in many respects (e.g. general structure, overall payment model, national leadership) but that differ in meaningful and well-documented ways [12]. In addition, we present rarely-accessible information about user-centered design practices that are not necessarily led by informatics researchers.

With these data, we assess which of four user-centered design practices work best to ensure that CDS accomplishes its stated goals. Namely, we consider four practices that are recommended by multiple guidelines for user-centered design [13–15]: 1) pilot testing CDS, 2) assessing provider satisfaction, 3) assessing usability, and 4) analyzing the impact of CDS on performance improvement. We examine the association between each of these practices and the perceived utility of CDS. Each of these practices were hypothesized to be associated with higher perceived utility of CDS.

1.2. User-Centered design practices

All four of the user-centered design practices we examined are intended to improve the formatting and framing of CDS, and optimize its fit within the clinical workflow. They are also designed to help determine which applications of CDS should be retained and which should be discarded. The goals and processes of each user-centered design practice are elaborated below:

Pilot testing is a foundational aspect of software design, human factors, ergonomics, quality improvement, and nearly all frameworks for managing change within a complex system [7,16–18]. Published guidance on user-centered design of CDS recommends not only pilot testing but iterative testing [13,14]; however the limited time and resources available to local clinical informatics teams may preclude highly iterative processes. In this analysis, we examined pilot testing, a practice that is arguably a bare minimum for user-centered design.

Provider satisfaction assessment is a modest step toward usability testing: it serves as a rough gauge of the acceptability of clinical decision support. In the parlance of quality improvement, provider satisfaction assessment functions as a “balancing measure,” [18] that helps to determine whether short-term gains in technical quality of care come at the expense of provider and staff well-being. Reduced provider satisfaction is by no means the only potential unintended consequence of CDS but it is among the easiest to anticipate and can function as a proxy for other important organizational factors associated with care quality [19,20].

Formal usability assessment is the practice that is perhaps most emblematic of user-centered design. It often involves some combination of interviews, focus groups, questionnaires, and analysis of clinical artifacts in the name of evaluating the three dimensions of usability defined by the International Organization for Standardization (ISO): effectiveness, efficiency, and user satisfaction [2,21]. These dimensions are evaluated as properties of the *interaction* between a user (e.g. a provider) and the product (CDS) and not as inherent properties of the CDS itself.

Analyzing the impact of CDS on performance improvement helps to keep CDS goal-oriented, and can provide evidence as to whether CDS efforts are helping clinics meet quality targets. It is particularly germane at the VA because of the VA’s substantial infrastructure for measuring performance at multiple levels of the organization and targeting improvement efforts on the basis of those measures. For example, the VA’s External Peer Review Program (EPRP) defines clinical quality measures at a national level but delegates most development of computerized clinical reminders and disease-specific templates to individual VA medical centers [22]. The specific measures within EPRP have changed over time to reflect changing goals within the VA and new medical evidence, but have consistently included information about preventive care (e.g. the provision of important vaccinations and screenings), and other high-value practices in both inpatient and outpatient settings. This program is one of several performance improvement programs within the VA, with others focusing on, for example, patient experience of care [23], patient safety [24], and overutilization [25].

These four practices do not reflect the entirety of user-centered design, but are commonly-recommended, readily-implementable strategies for improving the utility of CDS. As illustrated in Table 1, each of the four user-centered design practices studied was explicitly recommended by the Healthcare Information and Management Systems Society (HIMSS) toolkit “Improving Outcomes with Clinical Decision

[1] VA = Veterans Affairs, CDS = Clinical Decision Support, RAP = Rapid Assessment Process, CPRS = Computerized Patient Record System.