Development of a Workflow Integration Survey (WIS) for Implementing Computerized Clinical Decision Support

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Abstract

Interventions that focus on improving computerized clinical decision support (CDS) demonstrate that successful workflow integration can increase the adoption and use of CDS. However, metrics for assessing workflow integration in clinical settings are not well established. The goal of this study was to develop and validate a survey to assess the extent to which CDS is integrated into workflow. Qualitative data on CDS design, usability, and integration from four sites was collected by direct observation, interviews, and focus groups. Thematic analysis based on the sociotechnical systems theory revealed consistent themes across sites. Themes related to workflow integration included navigation, functionality, usability, and workload. Based on these themes, a brief 12-item scale to assess workflow integration was developed, refined, and validated with providers in a simulation study. To our knowledge, this is one of the first tools developed to specifically measure workflow integration of CDS.

Introduction

The Institute of Medicine and National Academy of Engineering have advocated widespread adoption of information technology (IT) to improve quality, evidence-based practice, and to reduce medical errors[1-3]. One example of heath IT is computerized clinical decision support (CDS), which includes "any computer program designed to help health professionals make clinical decisions"[4].

Adopting a computerized CDS system is advantageous in that it can improve clinician decision-making, support adherence to evidence-based guidelines, and improve quality of care[1,5-8]. However, changing from a paper-based system to a computerized system can also be challenging, as this change could necessitate changes in workflow, such as modifying task assignments,[9] reorienting the personnel flow of a clinic to align with computer accessibility, or preventing ready access to previously available paper records[10]. Broadly, workflow is defined as the typical sequence of work activities. Indeed, research findings suggest that successful workflow integration can increase the rate with which providers adopt and use the new decision support[11-14]. Integrating decision support into workflow requires that the new technology is tailored such that it fits into the providers' workflow process for delivering patient care in a specific context[12,15].

Although integration failure is one of the most critical barriers related to adoption and sustained use of CDS, assessing the extent to which decision support is integrated into workflow is often not done. When workflow integration is assessed, the typical methods are observational (i.e., field tests, interviews, focus groups, observation)[16]. These qualitative methods provide a context-rich, in-depth understanding of the work setting; however, they can be time consuming. Furthermore, the metrics for assessing such integration are not well established. The goal of the present study was to develop a brief survey to assess the extent to which a computerized CDS tool is integrated into important domains of workflow. Survey development was part of a larger study aimed to identify factors and design strategies related to the integration of computerized CDS into workflow through extensive field observations and interviews at benchmark institutions for health IT.

Themes identified from data analyses of the larger study were organized around the sociotechnical systems theory, which views all organizations as being comprised of a technological (including the actual IT or decision support system) subsystem, social (or personnel) subsystem, and environmental subsystem (e.g., context, policy, economic, and legal influences). These subsystems are highly interrelated, such that changes to any one affect the others,

usually in unanticipated or dysfunctional ways. This interrelation of organizational subsystems is often called joint causation[17]. Recognizing how these subsystems can be best designed and interrelated is referred to as joint optimization. Joint optimization increases the likelihood of successful IT development, implementation, and sustainability. Based on the themes we identified using sociotechnical systems theory, survey items were generated, refined, pilot tested, and validated during a simulation study.

Methods

Survey Development

Setting: Qualitative data was collected in 11 primary care outpatient clinics across four sites. The four sites included two Veterans Affairs (VA) Medical Centers (West Haven, Columbia), Regenstrief Institute, and Partners HealthCare System. Based on a recent review, these sites can be considered benchmark institutions as they are frequently cited for high quality research demonstrating the efficacy of CDS in improving quality and efficiency[18]. The primary intent for data collection was to observe best practices and identify barriers and facilitators to effective use of colorectal cancer (CRC) CDS for the various modalities of CRC screening: fecal occult blood test (FOBT), flexible sigmoidoscopy, and colonoscopy. This objective for the parent study included identifying elements that facilitated or prevented workflow integration, which were then incorporated into the survey's development.

Data Collection: The researchers conducted direct observation and opportunistic interviews of providers using CDS for colorectal cancer screening and follow-up, as well as key informant interviews and focus groups. The researchers used direct observation to understand the range of ways in which providers interact and use CDS tools in real time. During observations, two to four observers experienced in ethnographic observation separately shadowed providers and staff in clinics at four health systems as they interacted with CDS tools during an actual work shift. Observations were recorded via handwritten notes on a structured observation form during participant interaction with the CDS, capturing discrete activities and verbalizations. The structured observation form contained fields to record location, date, observer, actor (registered nurse 1, registered nurse 2, patient 1, patient 2, etc.), time of the observation, observation, and observer comments. Data was also gathered on the context and process surrounding CDS use. The study was approved by the Indiana University Institutional Review Board, the Indianapolis VA Medical Center Research Committee, and each individual study site. In total, 120 providers and staff were observed; and, 118 patients were observed.

Additionally, data collection methods included key informant interviews and focus groups. Key informants were identified as clinical champions for CDS and/or CRC screening. Eleven key informants discussed mechanisms and best practices used to facilitate CDS integration into workflow. At the two VA Medical Centers, all providers who participated in the observations were invited to participate in the focus groups. A total of 11 providers participated in two focus groups. Focus group discussions centered on barriers to CRC screening and screening follow-up.

Data Analysis and Item Generation: All data from the opportunistic interviews conducted during observations, key informant interviews, and focus groups were analyzed using a coding template, which was iteratively developed and refined during the coding process. The research team developed this coding template based on the aforementioned sociotechnical systems theory[17]. The coding template included a category for each component of a sociotechnical system: social subsystem, technical subsystem, and environmental subsystem. For each of these categories, subcategory labels were identified. The coding template (or codebook) was modified as coding proceeded and themes emerged from the data. A total of 23 observer-days were coded with 42 codes. Researchers created a unique, orthogonal definition for each code based on the data. Social subsystem codes included clinic work roles, CDS training, patient barriers to screening, staff perceptions of CDS, and CDS impact on clinical care. Technical subsystem codes included functionality, usability, rigidity in IT tools, coordination among providers for patient care, use of paper-based forms in conjunction with CDS tools, and redundant data entry. Environmental subsystem codes included staffing levels, patient workload, physical environment, and quality reporting. Once the analysis team had completed coding, data was merged into MAXQDA and coded segments were extracted by code. Findings were integrated across sites into meaningful patterns and the data abstracted into emergent themes, as guided by qualitative analysis norms.[19]

We used the themes that emerged as part of the technical subsystem as dimensions for the Workflow Integration Survey. These technical themes have a direct relationship with CDS usability and design as they illustrate factors that can facilitate or prevent successful integration into clinical workflow. These dimensions include the five following themes: navigation, functionality, usability, paper workarounds, and workload. *Navigation* refers to how logically information is organized and how easily information is located in the computer system. *Functionality*

includes the extent to which the computer system has tools or operations available to complete tasks that are necessary, such as the ability to order tests. *Usability* is how easy or hard it is to use the information system. *Paper workarounds* refer to the persistence of paper-based documentation or paper-based notes when a computer system is available. *Workload* includes the degree to which the computer system increases the amount of effort (e.g., data entry, tasks, number of clicks) to perform necessary actions.

Two researchers within the parent team created multiple items for each dimension. These items were pooled and revised. The initial item pool consisted of 19 items. Three content experts reviewed these items and rated each for clarity and importance for evaluating workflow integration. As a result of their input, five items were removed, one new item was created, and the remaining items were revised.

Pilot Testing: Nine primary care physicians at one VA Medical Center completed the Workflow Integration Survey. They were instructed to complete the survey in reference to their current electronic health record, the VA's Computerized Patient Record System (CPRS) focusing on how they use the record system during patient exams. A 5-point Likert type response set was provided (1=strongly disagree, 5=strongly agree). They were also given the opportunity to provide feedback about the clarity of the items. As a result of their feedback, the survey was revised again. The paper workaround items were removed due to respondents indicating that they do not routinely use CPRS during patient encounters; the use of paper during patient encounters had become a normative workflow and social norm at the site. The final Workflow Integration Survey consists of 12 items (3 items per dimension) as shown in Table 1. Items are rated on a 5-point Likert scale (1=strongly disagree, 5=strongly agree) with the option to respond 'Don't Know.' Six items are reversed scored such that a high score indicates greater workflow integration. The entire Workflow Integration Survey is shown in the Appendix.

A simulation study was conducted with primary care providers to validate the Workflow Integration Survey. As part of the parent study, new design features for a clinical reminder were developed. In the simulation study, participants were testing these new design features by participating in simulated patient exams. This format provided a realistic scenario for researchers to collect data on how the target clinical reminder was integrated into participant's actual workflow.

A within-subjects design was used such that participants completed two patient scenarios using the existing version of CRC CDS and the enhanced CDS version (with additional design features). The presentation order of the two versions of CDS was counterbalanced across participants. The Workflow Integration Survey was administered after the participant had finished both patient scenarios for a given CDS version, a total of two times per participant. Scores for the Workflow Integration Survey were compared across the two versions of CDS using Wilcoxon signed-rank test; within-subject comparisons were made between the survey subscales. The statistical tests were two-tailed with a 0.05 level of significance.

Dimension	Item
Navigation	▪ Patient information is easy to find in CPRS. ▪ Patient information is easily accessed with CPRS. ▪ With CPRS, it is difficult to search for patient information during face-to-face encounters.*
Functionality	▪ CPRS has all of the functions (e.g., order entry, medication list) needed to complete face-to-face patient encounters. ▪ CPRS helps you perform the tasks (e.g., order entry, progress notes, record review) you need to during face-to-face patient encounters. ▪ The same information is entered into CPRS multiple times during face-to-face patient encounters.*
Usability	▪ CPRS is challenging to use.* ▪ CPRS is easy to use. ▪ CPRS is frustrating to use.*
Workload	▪ Using CPRS during face-to-face patient encounters adds effort (e.g., typing, clicks).* ▪ Using CPRS during face-to-face patient encounters increases workload.* ▪ CPRS helps you complete face-to-face patient encounters efficiently.

Table 1. Dimensions and Items in Workflow Integration Survey (* indicates items that are reverse-scored)

Results

Twelve primary care providers from five outpatient clinics at the Veterans Affairs Medical Center (VAMC) study site participated. Participants included nine medical doctors (MDs), two nurse practitioners (NPs), and one doctor of osteopathic medicine (DO). Data was not collected for two participants for the enhanced version of CDS because of time constraints (both viewed the current CDS version first). Therefore, the results in Table 2 for the Workflow Integration Survey are based on ten paired comparisons. Finally, an experimenter error for one participant resulted in the administration of only one of the two patient scenarios for both versions of CDS. Therefore, results reported in Table 2 include scores for one participant based only on one patient scenario for both CDS versions.

The Workflow Integration Survey revealed good internal reliability (for CDS, $\alpha = 0.93$; for enhanced CDS, $\alpha = 0.80$). Analysis revealed that the enhanced CDS version was rated significantly higher (better) than current CDS version for each of the four survey subscales (Table 2).

Workflow Integration Survey subscale	CDS	Enhanced CDS	p-value (two-tailed)
Navigation	2.5 (0.9)	3.8 (0.6)	0.011
Functionality	3.1 (0.7)	4.0 (0.6)	0.008
Ease of use	3.2 (1.0)	3.6 (0.9)	0.049
Workload	2.3 (0.8)	2.9 (0.6)	0.028

Table 2. Means (standard deviations) and p-values from Wilcoxon signed rank tests for the Workflow Integration Survey for both versions of the CDS; the 12 survey items were grouped along four subscales (navigation, functionality, ease of use, and workload).

Discussion

The overall purpose of this study was to develop a brief survey to assess workflow integration of computerized CDS in a clinical seting. Other established instruments for assessing human-computer interaction characteristics of CDS tend to focus on constructs such as workload (e.g., NASA Task Load Index[20,21]) and usability (Computer System Usability Questionnaire; CUSQ[22]). However, no single instrument measures multiple dimensions that contribute to integrating CDS into workflow specifically in healthcare settings.

The dimensions of the Workflow Integration Survey are based on themes that emerged as part of a larger multimethod study to understand barriers and facilitators to workflow integration of CDS for CRC screening. These themes are consistent with other findings regarding workflow and health IT[23,24]. For example, both workload and usability are common metrics for assessing the suitability of computerized CDS tools[25,26].

When a CDS tool is not well integrated, the dimensions of the Workflow Integration Survey should elucidate some of the specific reasons why there are problems. For example, low scores on the functionality subscale would suggest that there are key functions missing from the CDS tool. We recommend this survey be administered specifically to evaluate a new or existing software tool in order to indicate potential problems with workflow integration. The goal of the Workflow Integration Survey is not to diagnose *what* problems may exist with respect to integration of a CDS, instead the goal of the survey is to provide developers with a view into *where* a problem might lie (e.g., navigation, functionality) and inform future development efforts. Ethnographic observation, interview methods, or other resource intensive methods might follow a poor Workflow Integration Survey score to identify the breakdown in routinely using a CDS tool.

The Workflow Integration Survey was designed to assess the extent to which computerized CDS tools are being integrated and used at the point-of-care. Some CDS tools may be used before or after a face-to-face patient encounter. However, computerized CDS tools are typically intended for use at the point-of-care. The Workflow Integration Survey may provide the first indication that a CDS tool is not being used at the point-of-care if respondents select the 'Don't Know' option for items related to 'face-to-face patient encounters.' The use of the Workflow Integration Survey may be best suited for simulation studies or when implementing a new or redesigned CDS tool that is intended to be used during the face-to-face patient encounter. The Workflow Integration Survey can be easily adapted for evaluating the extent to which particular computer systems are integrated. For the simulation

study, the survey was adapted for use with electronic health records in VA Medical Centers. Specifically, the name of the VA electronic health record ('CPRS') replaced the generic term 'computer system.'

Future Work: Further validation for the Workflow Integration Survey is planned pending funding of a follow-on grant. First, a confirmatory factor analysis will be conducted to validate the factor structure of the Workflow Integration Survey. Additionally, convergent validity will be established by administering other validated surveys with the Workflow Integration Survey to a larger sample.

Limitations: The survey development process included a limited number of participants in a simulated scenario evaluating one CDS tool. Further, the survey was only tested with providers from one VA facility. The Workflow Integration Survey requires broader testing to determine its validity with other providers and with various CDS tools. Likewise, the Workflow Integration Survey targets workflow integration in an outpatient clinic setting. Further revision might be necessary to assess CDS workflow integration in other clinical settings (i.e., inpatient, surgical) where there are different workflow processes. Also, the paper workaround subscale (removed for the simulation study) has not yet been tested with a sample that typically uses computerized CDS tools during patient exams.

Conclusions

The key dimensions of workflow integration were used to create a tool to assess the extent to which computerized CDS is integrated into provider workflow. The ability to measure whether a new CDS tool is being properly integrated into workflow should help identify problems with implementation and incompatibilities between context and CDS tool use. Using a survey to assess workflow integration is novel. The short amount of time required to complete a 12-item scale has the potential to dramatically reduce the resources required to determine the extent to which a CDS tool is integrated into workflow.

This study represents an important first step in developing a workflow integration instrument. As CDS and other health information technologies continue to be developed for multiple comorbid conditions and migrate beyond large teaching hospitals to smaller, community based health care systems, workflow integration will become an increasingly visible issue. Surveys or other tools to assess workflow integration and highlight potential problem areas will go a long way toward helping a broad range of health care systems effectively integrate and exploit the many benefits of optimally designed and deployed CDS in improving care.

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Appendix

System Evaluation Survey

Please think about the work involved in using CPRS during patient encounters and please rate the extent to which you agree with each of the following statements. Patient encounter refers to the face-to-face time that you spend with patients. Please use the scale below where 1=strongly disagree and 5=strongly agree.

In your assessment, to what extent do you agree that:	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE	DON'T KNOW
1. Patient information is easy to find in CPRS.	1	2	3	4	5	9
2. CPRS has all of the functions (e.g., order entry, medication list) needed to complete face-to-face patient encounters.	1	2	3	4	5	9
3. CPRS is challenging to use.	1	2	3	4	5	9
4. CPRS decreases your dependency on paper and handwritten notes during face-to-face patient encounters.	1	2	3	4	5	9
5. Using CPRS during face-to-face patient encounters adds effort (e.g., typing, clicks).	1	2	3	4	5	9
6. Patient information is easily accessed with CPRS.	1	2	3	4	5	9
7. CPRS helps you perform the tasks (e.g., order entry, progress notes, record review) you need to during face-to-face patient encounters.	1	2	3	4	5	9
8. CPRS is easy to use.	1	2	3	4	5	9
9. Rather than use CPRS, you typically make handwritten notes during face-to-face patient encounters.	1	2	3	4	5	9
10. Using CPRS during face-to-face patient encounters increases workload.	1	2	3	4	5	9
11. With CPRS, it is difficult to search for patient information during face-to-face encounters.	1	2	3	4	5	9
12. The same information is entered into CPRS multiple times during face-to-face patient encounters.	1	2	3	4	5	9
13. CPRS is frustrating to use.	1	2	3	4	5	9
14. You have developed paper workarounds so that you do not need to use CPRS during face-to-face patient encounters.	1	2	3	4	5	9
15. CPRS helps you complete face-to-face patient encounters efficiently.	1	2	3	4	5	9