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Abstract

Eighty four health care professionals participated in an online survey assessing the usability, and clinical and administrative impact of the Idaho Health Data Exchange's (IHDE) Virtual Health Record (VHR). The IHDE VHR allows authorized users to use a secure web interface to view lab, radiology and transcribed reports from multiple facilities and view medical histories on patients in the data exchange. Results indicate the usability of the IHDE VHR was almost universally positively rated with the Software Usability Measurement Inventory (SUMI) utilized as the assessment method. Medical providers however had the lowest rating of the exchange, raising concerns about the need for additional training and support. The addition of other Idaho health care organizations to the health data exchange was most widely desired, with the most frequently cited benefit being more comprehensive access to patients' records. In contrast to other published evaluations of health data exchanges in the U.S., few of the concerns emerged about cost of implementation of the data exchange or trust in the quality of information contained therein.

Keywords: health record, user computer interface

Introduction

Usability testing is increasingly recognized as critical to the development of successful software applications [1,2]. The results of usability testing attest to whether a given product "…can be used by specified users with effectiveness, efficiency, and satisfaction". ISO 9241-11 International Organization for Standardization [3]. In the arena of healthcare information technology however, usability testing has sometimes been given short shrift [4,5]

As discussed in the 2011 Agency for Healthcare Research and Quality (AHRQ) report on the usability and electronic healthcare records (EHR), determination of usability is particularly important for EHRs and in turn, Health Data Exchanges (HDEs) which merge a range of medical information into one shared and protected electronic depository [6]. In principle, HDE offer improved access to test results, reduced staff time, reduced prescribing errors, improved patient outcomes, reduced patient admissions, decreased redundant testing, and improved patient safety [7].

Evaluations of health data exchanges in the U.S. show some decreases in duplicative testing, emergency department admissions and associated costs [8-9]. However, the impact of HDEs does not always run in the positive direction expected nor are the findings consistent from study to study [10]. One factor potentially contributing to this state of affairs is the relatively low use of a HDE by providers and their staff. Against the promise of the usefulness of shared patient data, usage rates are surprisingly low in some systems [11]. Investigations of why health care professionals decide to use a HDE have focused on time constraints, cost burden, concerns about confidentiality of protected health

information, and other operational issues, [12] but with little attention to basic user interfaces [13]. One study has been published on the usability of a regional health information exchange with the finding of an overall positive rating however satisfaction with the data exchange varied according to level of users' professional training [13].

This Idaho study and report summarizes user feedback on the usability, and perceived clinical and administrative impact of a state supported HDE according to three groups of health care professionals (providers (MD, DO, PA, NP), licensed health professionals (RN), and staff members) with documented access to the exchange. Usability was assessed with a questionnaire, one method of evaluating usability recommended for clinicians [6].

The Idaho Health Data Exchange (IHDE) was established by the Health Quality Planning Commission as a 501(c)(6) non-profit corporation in 2008. IHDE is charged with establishing and maintaining a network of private and secure health information for both healthcare providers and patients. Currently there are almost 1,700 health care providers in Idaho sharing 1.97 million medical records through the electronic system. At the patient level, the exchange is based on an opt-out provision except for the Veterans Administration which is based on an opt-in provision. The IHDE VHR allows authorized users to access a secure, hyperlinked web interface to view lab, radiology and transcribed reports from multiple facilities as well as view medical histories on patients in the data exchange. A summary tab presents the last five clinical transactions and may include lab results, radiology reports, discharge summaries, charts, progress and surgery center notes, and cumulative lab reports. All lab values are accompanied with printed and visually supported reference ranges from the lab performing the test. Radiology reports include the names of the individuals performing, reading and verifying the image. Patient information included in the VHR are items such as insurance coverage, medications filled through enrolled pharmacy providers, expired prescriptions and medications, encounters by date and name of provider, and status of advance directives.

Methods

Selection and recruitment of Idaho health data exchange (IHDE) respondents

Registered users of the IHDE were recruited for participation. Twenty-one providers (MD, DO, PA or NP), 26 licensed health professionals (RN) and 37 staff responded to an online survey. Categorization of healthcare professional groups allowed analysis of satisfaction with the IHDE according to professional role. Providers were more likely to be hospital based, somewhat younger in age and female as compared to the other two groups. All users were voluntarily accessing records in the exchange, and information-seeking efforts could only be defined as a record of the user logging onto the system.

Survey Instrument

Per Cusack et al., [14] recommendations for evaluation of health information exchanges, a mixed methodology was used combining an online semi-structured survey with telephone interviews. The Software Usability Measurement Inventory (SUMI) [15] survey instrument was used for obtaining user feedback about the IHDE VHR. The SUMI instrument was developed in the late 1980s and has been widely used to assess the usability or user satisfaction with a range of software products in the United States and Europe by users with experience with the system being studied [16]. The SUMI is a proprietary tool requiring a user fee which in this case was $1,700 U.S. A minimum of 10 users is required for statistically valid results. The SUMI subscales are standardized so that the results can be compared to a normal or standard distribution with a mean of 50 and a standard deviation of 10. Coefficient alphas range from .71 to .92 across the subscales with an overall alpha of .83.

The survey was composed of 50 items which have been statistically identified with five subscales. The higher the score, the more positive the user's rating of the software on each of the subscales. Users typically take 5-8 minutes to complete the survey. The protocols for offering both the online and the telephone survey were approved by the Boise State University Institutional Review Board. The subscales are described below and align with the dimensions of usability recommended by Neilson [2].

1. Affect (likeability) subscale: the user's general emotional reaction to the software. High affect reflects users who find using the software satisfying and interesting.
2. Efficiency subscale: the degree to which users feel that the software assists them in their work and performs in a predictable, consistent manner.

3. Helpfulness subscale: the degree to which the software is self-explanatory, as well as the adequacy of help facilities and documentation.
4. Control subscale: the extent to which the user feels in control of the software, as opposed to being controlled by the software, when carrying out the task.
5. Learnability subscale: the speed and facility with which the user feels that they have been able to master the system, or to learn how to use new features when necessary.

The online survey was also used to assess the clinical and administrative impacts, and to identify assets and challenges of the IHDE. In addition to the SUMI instrument there were 21 questions developed and derived from published reports on benefits and barriers documented for other health data exchange systems (Table 2). The questions were grouped into the following categories: (1) workflow efficiency; (2) quality of care and patient safety; (3) patient-provider communication; (4) cost savings revenue; (5) savings in the overall health care system; and (6) costs of implementation,and these questions were added to the online SUMI survey.

To supplement findings from the SUMI, follow-up telephone interviews were done with 14 of the respondents. To save time, a list of interview questions was provided to each participant in advance. Interview questions were tailored to user roles (clinician or staff), and were designed to assess VHR utilization practices, effects on workflow, decision making processes, new patient care, and percieved costs/savings due to use of the VHR. Respondents were also asked if they had suggestions for improvement, or additional training needs.

Survey Administration Process

The survey was made available online using the SUMI online survey software supported by the Human Factors Research Group, University College Cork, Ireland. All data were collected in the spring of 2013. An initial email was sent from IHDE staff to each target health care system's IT department to alert users of the upcoming survey.

A second e-mail was sent to potential participants introducing the survey and explaining the study, with a link to an informed consent form and an offer of a $25 gift certificate in exchange for participating in the study. A survey reminder was sent 12 working days later. The final data file was checked to confirm that there were no duplicate responses.

A total of 566 e-mail invitations with the subject line "Opportunity to give feedback on the Idaho Health Data Exchange" were sent out to known IHDE users. SUMI tracking services reported that 30 invitations were returned as undeliverable, 163 were received and opened, and 129 recipients requested the informed consent page from the server. Of the 129 recipients who requested the informed consent page, 85 agreed to participate in the survey, for an acceptance rate of 66%. There was a 99% completion rate. Seventy four survey participants provided an email address, for the $25 gift card. It is unknown how many of the invitation e-mails went to a junk email or "spam" box and therefore were not seen by potential recipients.

Analysis

Data were analyzed with SPSS 21 statistical software [17]. Survey scales were checked for normality using the one-sample Kolmogorov-Smirnov Test and were found to be normally distributed. Therefore, a one-way Analysis of Variance was used to examine the differences between groups on the SUMI scales.

Results

Software usability measurement inventory (SUMI) analyses

A statistically significant association was seen between professional role and personal rating of software skills and knowledge (chi-square = 10.91, p =.03). Providers were distributed approximately equally across the three levels of perceived skills (no respondent selected the "I find most software difficult to use" option). The majority of licensed

health professionals and staff rated themselves as good but not very technical. Staff were most likely to assess themselves as the most experienced of the three groups. The results of an Analysis of Variance found no differences according to self rating of software skills and responses to the SUMI subscales.

Each user group is described in Table 1 with the range of scores, the mean score and standard deviation. Overall as compared to the two other groups, providers had the lowest ratings of the usability of the IHDE VHR. The differences were statistically significant ($p \leq .05$) among the three professional groups for the Global subscale, Affect subscale, the Helpfulness subscale and Learnability subscale. Marginally statistically significant differences ($p \leq .10$) were observed for the Efficiency and Controlability subscale with the providers again giving the lowest ratings. The providers' average ratings were half a standard deviation below the mean of 50 for three of the scales and approximately a quarter of a standard deviation below the mean for the remaining three scales.

Table 1 Summary of Usability Assessment of Virtual Health Record

	Mean	Std. Error	95% Confidence Interval		F Statistic	p value
			Lower Bound	Upper Bound		
Global					3.34	p = .04*
Provider	47.143	3.142	40.892	53.394		
Licensed	55.654	2.824	50.036	61.272		
Staff	56.973	2.367	52.264	61.682		
Efficiency					2.48	p = .09
Provider	45.667	3.508	38.687	52.646		
Licensed	53.808	3.152	47.535	60.080		
Staff	55.135	2.643	49.877	60.393		
Affect					4.84	p = .01**
Provider	45.952	3.203	39.579	52.325		
Licensed	55.846	2.879	50.119	61.574		
Staff	57.622	2.413	52.820	62.423		
Helpful					3.13	p = .05*
Provider	48.952	2.857	43.268	54.637		
Licensed	56.923	2.568	51.814	62.032		
Staff	57.405	2.152	53.123	61.688		
Control					2.73	p = .07
Provider	45.333	2.949	39.466	51.201		
Licensed	52.385	2.650	47.111	57.658		
Staff	53.730	2.222	49.309	58.150		
Learning					3.15	p = .05*
Provider	47.429	3.046	41.368	53.489		
Licensed	54.115	2.737	48.669	59.562		
Staff	56.973	2.295	52.407	61.539		

**$p \leq .01$, *$p \leq .05$

A statistically significant association was found between professional role and perceived importance (chi-square = 13.46, p = .04). Twenty nine percent (6) of the providers deemed IHDE as "not important" or "not important at all" and three (8%) staff deemed IHDE "not important."

Rating of Clinical / Administrative Impact

Table 2 summarizes the responses by domain according to provider role. Improved access to test results from outside practices was the most frequently selected asset within workflow efficiency. Improved coordination of care was the most frequently selected asset within improved quality of care and patient safety. Improvement in the completeness of records was the most endorsed asset within enhanced patient-provider communication. For cost savings/increased revenue, the majority of respondents selected "none of the above". However, the majority of respondents also believed

reductions in redundant testing as a savings to the overall health care system. Finally, the majority of respondents did not ascribe to any of the four possible cost concerns presented. Across all domains, improved access to test results from outside practices was most frequently selected as an overall asset followed by improvements in completeness of records.

Table 2 Clinical and Administrative Assets and Challenges According to Professional Role

	Provider (MD, DO, PA, NP)	Licensed Health Professional (RN)	Staff (MA, Reception, Lab/X-ray Technician)	Literature Reference Number
Workflow efficiency				7, 19, 21-24
Improved access to test results from outside practices	19(90%)	24(92%)	31(84%)	7, 20, 24
Improved referral process and claims processing	7(33%)	7(27%)	11(30%)	7
Decreased staff time required for handling test results	12(57%)	10(38%)	17(46%)	7, 20
Improved electronic access to test results from outside the practice	16(76%)	16(62%)	22(59%)	7, 14, 19, 23, 25, 27
None of the above	0	0	0	
Improved quality of care and patient safety				
Improved coordination of care	20(95%)	24(92%)	28(76%)	7, 19, 27, 30
Prevention of medical errors	7(33%)	6(23%)	13(35%)	28, 29
Reduce hospital admissions	3(14%)	2(8%)	4(11%)	7, 20, 30
Decreases in prescribing errors	7(33%)	10(38%)	8(22%)	7
None of the above	6(29%)	5(19%)	9(24%)	
Enhance patient-provider communication				7, 19, 24, 27, 31
Improvements in completeness of records	19(90%)	23(88%)	33(89%)	14, 19-20, 23, 25-28, 30, 31, 34
Improvements in accuracy of records	18(86%)	17(65%)	23(62%)	14, 19-20, 23, 25-28, 30, 31, 34
Improvements in communication with other providers	18(86%)	19(73%)	24(65%)	7, 14, 23, 25, 27
None of the above	0	0	0	
Cost savings/increased revenue				
Reductions in the cost of testing agencies that deliver test results	9(43%)	9(35%)	12(32%)	7
Reductions in staff time for claims processing	5(24%)	6(23%)	7(19%)	7, 18
Reductions in the cost of paper storage	11(53%)	12(46%)	14(38%)	7
None of the above	15(71%)	13(50%)	20(54%)	
Savings in the overall health care system				
Reductions in redundant testing	19(90%)	20(77%)	25(68%)	7, 18, 20, 28, 30, 32
Improving medical decision making that shortens hospital stays	13(62%)	9(35%)	15(41%)	7, 18, 19, 21, 28
Neither of the above	6(29%)	7(27%)	12(32%)	
Cost concerns				

Start-up costs: direct cost of hardware, software and technical assistance	7(33%)	7(27%)	4(11%)	7, 14, 20, 23, 25, 33
Indirect costs: initial reduced productivity because of changes in workflow	3(14%)	7(27%)	3(8%)	7
Security/privacy/liability concerns	7(33%)	5(19%)	10(27%)	7, 9, 21, 24, 30, 32, 34
Lack of nationally recognized standards for data codes, storage and retrieval	2(9%)	4(15%)	5(14%)	7, 9, 27, 30, 35

Across the three groups, a desire for more sites participating in the data exchange was the most frequently offered suggestion in the write-in text box at the end of the survey. In total, 39% of the respondents cited increased participation of other health care organizations in the IHDE as their chief suggestion for improvement. Improved user interface was the second most frequently offered suggestion for improvement (17% of total sample).

Interview results

The major trend categories for the telephone interviews included improvements in patient care management, cost savings gained from use of the VHR, VHR expense concerns per practice, reduction of duplication of services, incomplete information in the VHR due to lack of state-wide users, and the VHR serving as a major time saver for clinicians. Several VHR users stated they would participate in training offered by the IHDE. There was an interest in and suggestions for functionality improvement in order to increase the usability of the VHR. Frequent users wanted to see additional information for more patients which they suggested could be accomplished by increasing the number of users or by including patient records from small hospital systems.

Discussion

This cross-sectional survey profiles a group of Idaho health care professionals using the IHDE VHR who feel they are proficient with software but not expert software users. Limitations of the study include the fact that the respondents' actual levels of IHDE VHR use (e.g., numbers of patients/records viewed) were not measurable due to patient record access and system reporting limitations. In addition, generalizability of the survey results is limited by self-selection of the respondents and the predominantly rural, geographically dispersed population of Idaho.

Differences in perceived usability and importance of the IHDE across the three user groups raise questions for training and further evaluation. Of particular note is the providers' lower standing on all dimensions of the usability assessment and the greater number of providers stating that the IHDE is not important to them. The feedback suggests that more attention be given to basic learnability and explanation of the software as well as third party payers expanding expectations for use of electronic based healthcare information. The challenge becomes how to effectively achieve this support within the context of clinical practice for providers central to workflow and patient care.

Other evaluation methods for usability would provide more direction for technical support of users, but as noted by Johnson et al. in their report to AHRQ, these methods are not easily deployable in clinical practices [6]. Further, comparisons of these methods (heuristic evaluation, cognitive walk through and think aloud) place none above the other in terms of ease of use and quality of information gathered [4]. Efforts have been made to develop rapid evaluation methods for assessment of healthcare's clinical data, but this approach may too be beyond the capacity of many clinical systems [36].

Nonetheless, the importance of usability assessments for electronic health care information is likely to continue or even escalate as clinicians are expected and incentivized to use this information more comprehensively and longitudinally for patient care [37]. As a case in point, recent analyses of primary care physicians' use of electronic health information to meet Meaningful Use requirements show significant gaps in how many clinicians use their data systems for patient registries (47% no), patient communication (55% no) and other required functionalities [38]. Usability assessments are one point from which to determine how best to assist clinicians in their journey with electronic health information.

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Competing Interests

No competing interests declared for Janet Reis, Lisa MacKenzie, Terri Soelberg or Jennifer Smith.

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