



EHR Usability Test Report of the Convergence Care EHR (Version 7.21)

Report based on NISTIR 7742 Common Industry Format for Usability Test Reports

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Executive Summary

On August 12th to August 17th 2021, The Usability People, LLC conducted a summative usability test of the Convergence Care EHR. The test was conducted in the Fairfax, VA office of The Usability People over individual remote tele-conferencing sessions. The purpose was to test and validate the usability of the current user interface and provide evidence of usability of the Convergence Care EHR as the EHR Under Test (EHRUT). Ten (10) healthcare providers matching the target demographic criteria participated in the usability test using the EHRUT in simulated, but representative tasks.

The study focused on measuring the effectiveness of, efficiency of, and satisfaction (ISO 9241) with the Convergence Care EHR among a sample of participants representing potential users of the system. Performance data was collected on sixteen (16) tasks typically conducted on an EHR. Tasks created were based upon the criteria specified within the test procedure structure for evaluating conformance of Electronic Health Record (EHR) technology to the certification criteria defined in certification criteria identified in 45 CFR Part 170 Subpart C of the Health Information Technology: 2015 Edition Health Information Technology (Health IT) Certification Criteria Cures Update Edition.

Results of the study indicated that the Convergence Care EHR system was satisfactory with regards to effectiveness and efficiency and that the participants were satisfied with the system.

Introduction

The Electronic Health Record System Under Test (EHRUT) tested for this study, the Convergence Care EHR (V7.21), was specifically designed to present medical information to healthcare providers on desktop computers in standard healthcare settings. This study tested and validated the usability of the Convergence Care EHR software user interface and provides evidence of the usability of the Convergence Care EHR with representative exercises and in realistic user conditions. To this end, measures of effectiveness and efficiency, such as time on task, number of errors made, and completion rates were captured during usability testing. Satisfaction was assessed, and user comments collected using two industry-standard questionnaires: The System Usability Scale (SUS) and the Computer System Usability Questionnaire (CSUQ).

Method

Participants

Ten (10) individuals (7 women and 3 men) participated in the EHRUT(s) using the Convergence Care EHR. Participants were physicians, nurses, and/or other healthcare/Health IT practitioners. Participants were recruited from a database of potential participants maintained by The Usability People, LLC. The contacts contained within this database were comprised from past participants of other summative studies, and via potential participants responses to postings in Internet and social media sites, and a link at the bottom of The Usability People's website. Those who responded to the invitation to take part in the study were directed to an online questionnaire that served as the participant screener. (The screening questionnaire is provided as Appendix A.) Participants meeting the criteria for participation in the study were contacted and scheduled via telephone and/or email.

Participants in the usability test of the Convergence Care EHR had a variety of healthcare backgrounds and demographic characteristics.

Table 1 presents participant characteristics, including demographics, professional experience, computing experience, and previous EHR experience. Participant characteristics reflect the audience of current and future users and meet the criteria designated in the 2015 Edition Certification Companion Guide for Safety-enhanced design - 45 CFR 170.315(g)(3). None of the participants were from the vendor organization (Cantata Health) that produced and supplied the evaluated system nor did any participant have any direct connection to the testing organization (The Usability People, LLC). All participants were compensated for their time.

Table 1. Participant Characteristics

Part ID	Gender	Age	Education	Role/Title	Professional Experience (Months)	Computer Experience (Months)	Experience with the EHRUT (Months)	Assistive Tech Needs
P01	Female	50 to 59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	RN	312	180	0	None
P02	Female	20 to 29	Trade technical vocational training	LPN	60	60	0	None
P03	Female	30 to 39	Master's degree	RN	180	156	0	None
P04	Female	40 to 49	Bachelor's degree	RN	36	36	0	None
P05	Male	30 to 39	Bachelor's degree	R.N.	120	120	0	None
P06	Female	50 to 59	Master's degree	RN Manager	312	180	0	None
P07	Male	50 to 59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	M.D.	324	108	0	None
P08	Male	50 to 59	Master's degree	Director of Information Systems	384	240	0	None
P09	Female	50 to 59	Master's degree	RN Manager	312	180	0	None
P10	Female	40 to 49	Bachelor's degree	Office Manager	120	72	0	None

Summary of Participant Characteristics:

Participants had experience with the occupation and expertise that aligns with the capability under testing. The cohort of users who are selected as participants was varied with the product and its intended users and was not limited to clinicians. The demographic characteristics of the test participant characteristics reflected the audience of current and future users.

Gender

Male	3
Female	7

Age Range

20 to 29	1
30 to 39	2
40 to 49	2
50 to 59	5
60 to 69	0
70 to 79	0

Education

Some college credit, no degree	0
Trade technical vocational training	1
Associate degree	0
Bachelor's degree	3
Master's degree	4
Doctorate Degree	2

Years of Experience with Convergence Care

None	10
Up to 3 years	0
3 to 5 years	0
5 to 10 years	0
More than 10 years	0

Study Design

The overall objective of this usability test was to uncover areas where the Convergence Care EHR system performed well – that is, effectively, efficiently, and with satisfaction – and areas where the system failed to serve the clinical documentation and workflow needs of users. Data from this test may be used as a baseline for future tests of updated versions of Convergence Care and/or for comparing Convergence Care software with other EHRs presenting the same tasks. In short, this testing serves as both a means to record or benchmark current usability and to identify areas where improvements must be made.

Participants had a range of experience with EHRs in general, but none had any prior experience with the Convergence Care system. Participants completed the Convergence Care usability study during individual 45–60-minute remote video conference sessions. During the test, each participant interacted with various components of the Convergence Care software system. Each participant was provided with the same instructions.

The Convergence Care EHR was evaluated for effectiveness, efficiency and satisfaction as defined by the following measures collected and analyzed for each participant:

- Number of tasks successfully completed without assistance
- Time to complete the tasks
- Number and description of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system

Tasks

A total of sixteen (16) tasks were constructed by The Usability People, LLC. (In collaboration with Cantata Health staff) to be realistic and representative of the activities a user might engage in while using Convergence Care in actual medical settings. The sixteen (16) tasks were created based upon the criteria specified within the test procedure structure for evaluating conformance of Electronic Health Record (EHR) technology to the certification criteria as defined in 45 CFR Part 170 Subpart C of the Health Information Technology: Standards, Implementation Specifications, and Certification Criteria for Electronic Health Record Technology. The tasks focused on a subset of the nine (9) 2015 Cures Update Edition certification criteria specified by ONC, specifically:

- Section 170.315(a)(1) Computerized provider order entry – medications
- Section 170.315(a)(2) Computerized provider order entry – laboratory
- Section 170.315(a)(4) Drug-drug, drug-allergy interaction checks
- Section 170.315(a)(5) Demographics
- Section 170.315(a)(9) Clinical decision support
- Section 170.315(a)(14) Implantable device list
- Section 170.315(b)(2) Clinical information reconciliation and incorporation

A copy of the tasks presented to participants in the usability test of the Convergence Care EHR can be found in Appendix C.

Test Location

All participants were tested on the Convergence Care EHR system during remote conferencing sessions. Each participant was requested in advance to secure a quiet room with minimal distractions and a desktop or laptop computer that could connect to the Internet with a remote video conference system. Although the type of computer, operating system and display resolution of the remote participant system was unknown, the system that was used by the test administrator and controlled by the remote participant was a Desktop computer running the Windows 10 operating system at a resolution of 1920x1080 pixels. During a given remote video conference session, only the test administrator and participant communicated with one another.

The remote usability test session was conducted by a test administrator from the testing organization (*The Usability People, LLC*) working at The Usability People's Fairfax, VA location. A data logger from the testing organization also took detailed notes on each session, including user comments and other ratings following each task. During a session both the test administrator and the data logger could see the participant's screen and hear the participant's comments, questions, and responses.

Test Environment

While the EHRUT typically would be used in a healthcare office, or in-patient center facility, testing of the Convergence Care EHR system was conducted via remote connection during individual remote video conference sessions. Each participant connected into a remote video conference session and was connected by the test administrator to the application.

The Convergence Care system itself was run from the Chrome browser running a Windows™ client platform on a broadband internet connection using a sample database that was set up specifically for the summative evaluation. Participants used a mouse and keyboard when interacting with the EHRUT and were given remote control of the administrator's workstation to perform the tasks.

Test Forms and Tools

As part of the usability test, several documents and instruments were used. Examples of the documents used during the usability test, including an informed consent form, the tasks, and post-test questionnaires, can be found in Appendices B to E, respectively.

Participant Instructions

The administrator read the following instructions aloud to each participant:

Thank you for participating in this study. Your input is very important. Our session today will last about 45 minutes. During that time, you will use an instance of an electronic health record. I will ask you to complete a few tasks using this system and answer some questions.

Please note that we are not testing you; we are testing the system. Therefore, if you have any difficulty this may mean that something needs to be improved in the system. I will be here in case you need specific help, but I am not able to instruct you or provide help in how to use the application.

Overall, we are interested in how easy (or how difficult) this system is to use, what in it would be useful to you, and how we could improve it. I did not have any involvement in its creation, so please be honest with your opinions. All of the information that you provide will be kept confidential and your name will not be associated with your comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Participants were then given tasks to complete.

Procedure

Upon connection to the online meeting tool, each participant was greeted, his or her identity verified, and matched to a name on the participant schedule. Participant demographic information was also verified, including information regarding overall computer experience and participant experience with the EHUT. Participant names were replaced with participant IDs so that a given individual's data cannot be linked to their identity. Prior to beginning testing, each participant reviewed and signed an informed consent form (See Appendix B).

Staff members of the Usability People, a usability test administrator, administered the test. The administrator moderated the session by providing both verbal and written instructions for the overall usability test and for each of the tasks comprising the test. The administrator also monitored task success, path deviations, number and description of errors, and participant verbal comments. A data logger logged task times, obtained post-task rating data, and took notes on participant comments and administrator feedback.

For each of the sixteen (16) tasks, participants were provided written instructions to their computers. The administrator prepared for each task by first navigating to an appropriate starting point for that given task. Following the administrator's instructions, each participant then performed each task by first reading the task then stating in their own words their interpretation of the task requirements. When the participant's interpretation matched the actual goal of the task, the administrator instructed the participant to begin and task timing began. Task time was stopped and recorded when the test administrator observed on their workstation that the participant had successfully completed the task. If a participant failed to complete a task before the expected amount of time for each task, that task was marked as "Timed Out." After each task, the test administrator asked the participant, "On a scale from 1 to 5, where 1 is 'Very Difficult and 5 is 'Very Easy,' how satisfied were you with the ease of use for this task?" This same procedure was conducted for each of the sixteen (16) tasks.

Following completion of sixteen (16) EHR tasks, the administrator electronically presented to the participant two post-test questionnaires (The System Usability Scale (SUS), see Appendix D and the Computer System Usability Questionnaire (CSUQ), see Appendix E). After the participant completed both questionnaires, the administrator thanked each participant for his or her time and allowed the participant to make any comments on or ask any questions about the system and/or the tasks presented.

For each session, the participant's schedule, demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire were recorded. The system was then reset to proper test conditions for the next participant.

Usability Metrics

According to the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records* (NIST IR 7741, November 2010) EHRs should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction. To this end, metrics for effectiveness, efficiency and user satisfaction were captured during the usability testing. The goals of the test were to assess:

- Effectiveness of the Convergence Care EHR software by measuring participant success rates and errors.
- Efficiency of the Convergence Care EHR software by measuring the average task time and path deviations.
- Satisfaction with the Convergence Care EHR software by measuring ease-of-use ratings.

Data Scoring

Table 2 details how tasks were scored, errors evaluated, and the time data analyzed.

Table 2. Scoring Protocols for Effectiveness, Efficiency, and Satisfaction

Measures	Rationale and Scoring
<p>Effectiveness:</p> <ul style="list-style-type: none"> • Task Success 	<p>A task was counted as “Success” if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis.</p> <p>The total number of Successes was calculated for each task and then divided by the total number of times that task was attempted. Results are provided as a percentage.</p>
<p>Effectiveness:</p> <ul style="list-style-type: none"> • Task Failures 	<p>If the participant abandoned the task, did not reach the correct answer or performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as “Fail.” No task times were taken for failed attempts.</p> <p>The total number of errors was calculated for each task and divided by the total number of times that task was attempted. Results are presented as the average error rate.</p> <p>Note: Not all deviations are counted as errors</p>
<p>Effectiveness:</p> <ul style="list-style-type: none"> • Prompted Successes 	<p>Because some tasks are dependent upon the successful completion of previous tasks, participants may receive a limited number of “prompts” to help prepare the system data for the pre-requisites for subsequent tasks.</p> <p>When a participant was able to complete the data entry on a task with 3 or fewer prompts, the task was counted as an “Assisted” completion. No task times were recorded for Assisted completions.</p>
<p>Efficiency:</p> <ul style="list-style-type: none"> • Task Deviations 	<p>The participant’s path (i.e., steps) through the application was recorded. Deviations occur if for example, the participant navigated to an incorrect screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control.</p>
<p>Efficiency:</p> <ul style="list-style-type: none"> • Task Time 	<p>Each task was timed from the administrator’s prompt “Begin” until said, “Done.” If the participant failed to say, “Done,” timing stopped when the participant stopped performing the task.</p> <p>Only task times for tasks that were successfully completed were included in the average task time analysis. Average time per task was calculated for each task.</p>

<p>Satisfaction:</p> <ul style="list-style-type: none"> • Ease of Use ratings • System Satisfaction 	<p>Participant’s subjective impression of the ease of use of the application was measured by administering both a single post-task question as well as two post-session questionnaires.</p> <p>After each task, the participant determined on a scale of 1 to 5 their subjective satisfaction with performance on the task. These data are averaged across participants.</p> <p>To measure participants’ confidence in and likeability of the EHR overall, the testing team administered electronic versions of the System Usability Scale (SUS) and the Computer System Usability Questionnaire (CSUQ). See the SUS questionnaire as Appendix D., and the CSUQ as Appendix E.</p>
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Results

Data Analysis and Reporting

The results of the usability test of the Convergence Care EHR software system were analyzed according to the methods described in the Usability Metrics section above and are detailed below. Note that the results should be evaluated relative to the study objectives and goals, as outlined in the study design section above. The data should yield actionable results that, if corrected, yield material, positive impact on user performance.

Reliability

During the data collection phase, it was observed that the system provided a consistent and reliable interface to each participant as they completed their tasks. As each participant completed their assigned tasks, the system provided the same information and responded to their input with the same verbiage and using the same mode of communication (e.g., Pop-up message, or embedded assistance).

Effectiveness and Efficiency

Table 3 presents a summary of overall task performance showing task, mean time on task, task completion rates, mean path deviations and mean task satisfaction:

Table 3. Usability Test Results

Task	Mean Task Time	SD	Completion Rate (%)	Mean # Path Deviations	SD	Mean Task Satisfaction	SD
Task 1 (a5) Demographics	2:09	1:06	90%	1.70	2.19	4.00	0.63
Task 2 (a5) Demographics - Modify	1:51	0:45	100%	1.10	1.22	4.50	0.50
Task 3 (b.2) Clinical Info Reconciliation--Medications	2:00	0:30	100%	1.10	1.37	4.40	0.66
Task 4 (b.2) Clinical Info Reconciliation--Allergy	1:33	0:21	100%	1.60	1.85	4.20	0.75
Task 5 (b.2) Clinical Info Reconciliation--Diagnosis	1:06	0:11	100%	0.40	0.49	4.50	0.50
Task 6 (a.14) Implantable Device List--Enter	1:22	1:19	70%	3.20	3.19	3.50	0.50
Task 7 (a.14) Implantable Device List--Modify	1:01	0:31	80%	1.80	2.52	4.20	0.75
Task 8 (a.1) CPOE--Record medication	1:13	0:30	90%	1.10	2.07	4.30	0.90
Task 9 (a.9) Clinical Decision Support--View	2:04	0:49	100%	0.30	0.64	4.40	0.49
Task 10 (a.1) CPOE Record medication--Modify	2:24	0:34	90%	1.40	1.74	4.40	0.92
Task 11 (a.9) Clinical Decision Support—Override	2:09	0:52	100%	0.80	0.87	4.70	0.46
Task 12 (a.2) CPOE--Record Lab order	1:15	0:38	90%	0.80	1.78	4.50	0.92
Task 13 (a.2) CPOE--Modify Lab order	1:34	0:27	100%	0.70	1.10	4.50	0.50
Task 14 (a.4) Drug-drug interaction check	1:17	0:10	100%	0.20	0.60	4.80	0.40
Task 15 (a.4) Drug-allergy interaction check	1:52	0:21	100%	0.50	0.67	4.20	0.75
Task 16 (b.2) Clinical Info Reconciliation—View data	1:23	0:26	100%	0.40	0.66	4.80	0.40

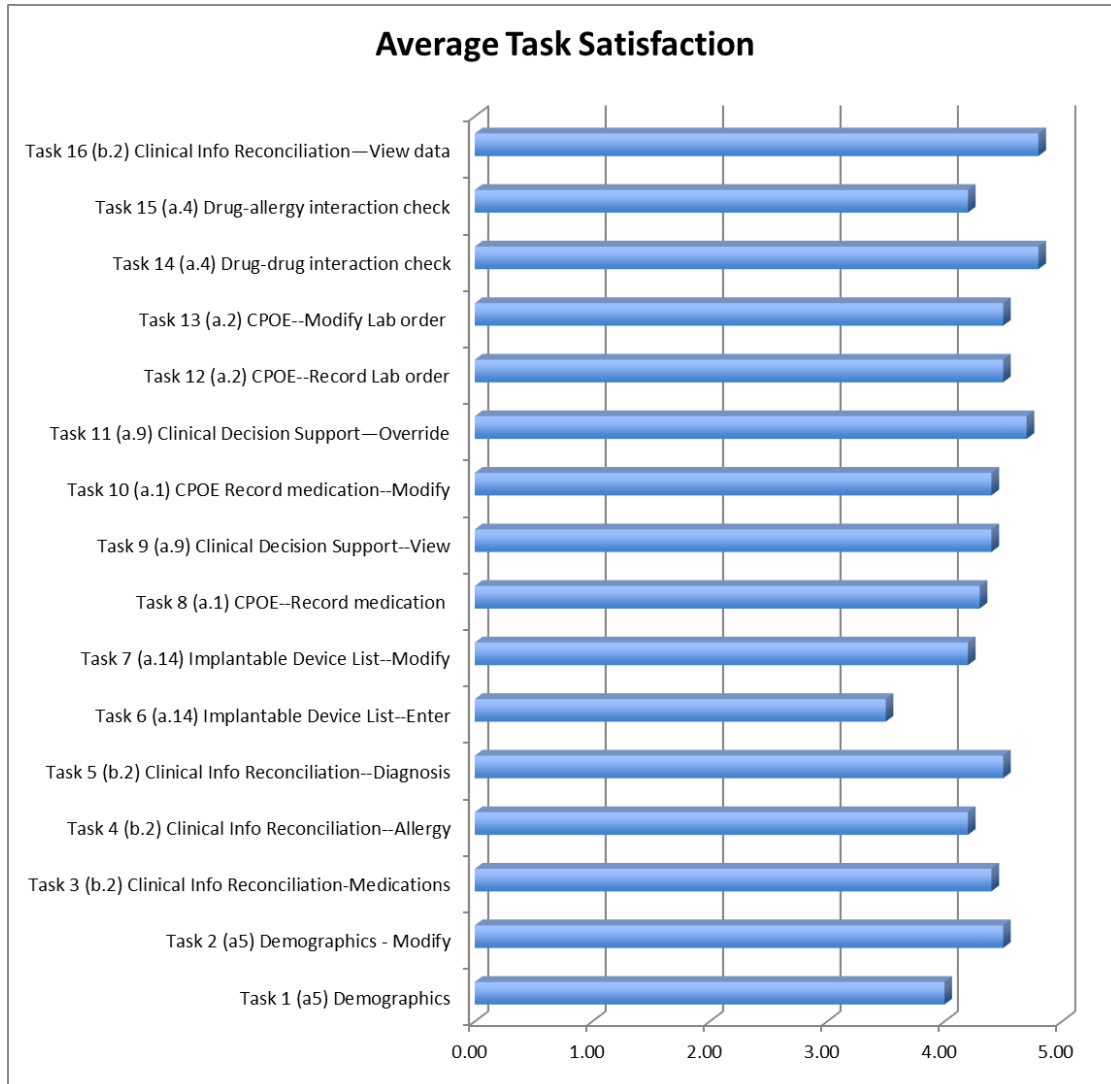
As Table 3 shows, relative to optimal performance standards as defined by Cantata Health and The Usability People, participant performance in the Convergence Care EHR software usability test was satisfactory. The overall average task completion rate was ninety-four (94) percent.

Satisfaction

Individual Task Satisfaction

Participants verbally indicated their satisfaction with the ease of use for each task using a scale of “1” (“Very Difficult”) to “5,” (“Very Easy”). As Figure 1 shows individual task satisfaction ranged from a low of 3.5 (out of 5) on Task 6 (*Implantable Device*) to a high of 4.8 (out of 5) on Tasks 14 and 16 (Drug-Drug Interaction Check, View CCD PDF). The overall average task satisfaction was 4.37 (out of 5).

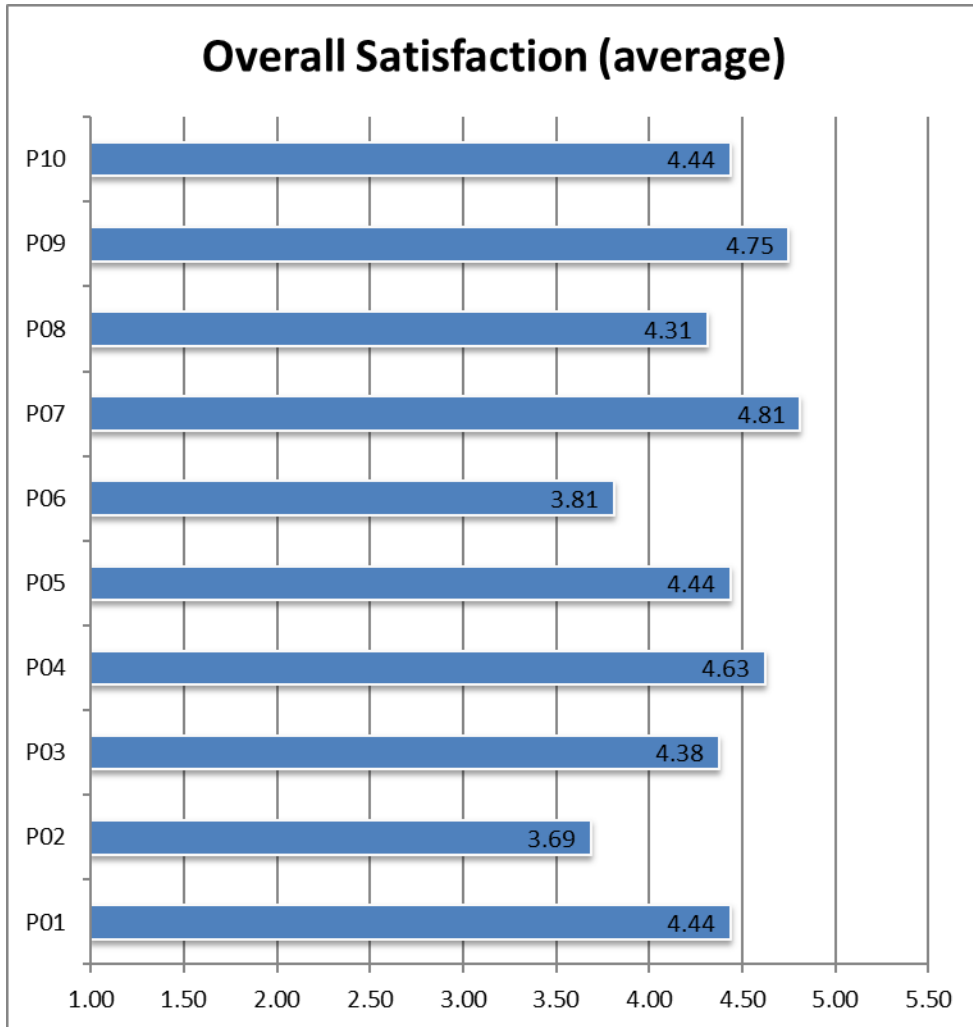
Figure 1. Satisfaction Ratings of Individual Tasks



Individual Participant Satisfaction

In general, the participants were satisfied with the ease of use of the Convergence Care EHR software

system. The following chart displays overall satisfaction for each participant:



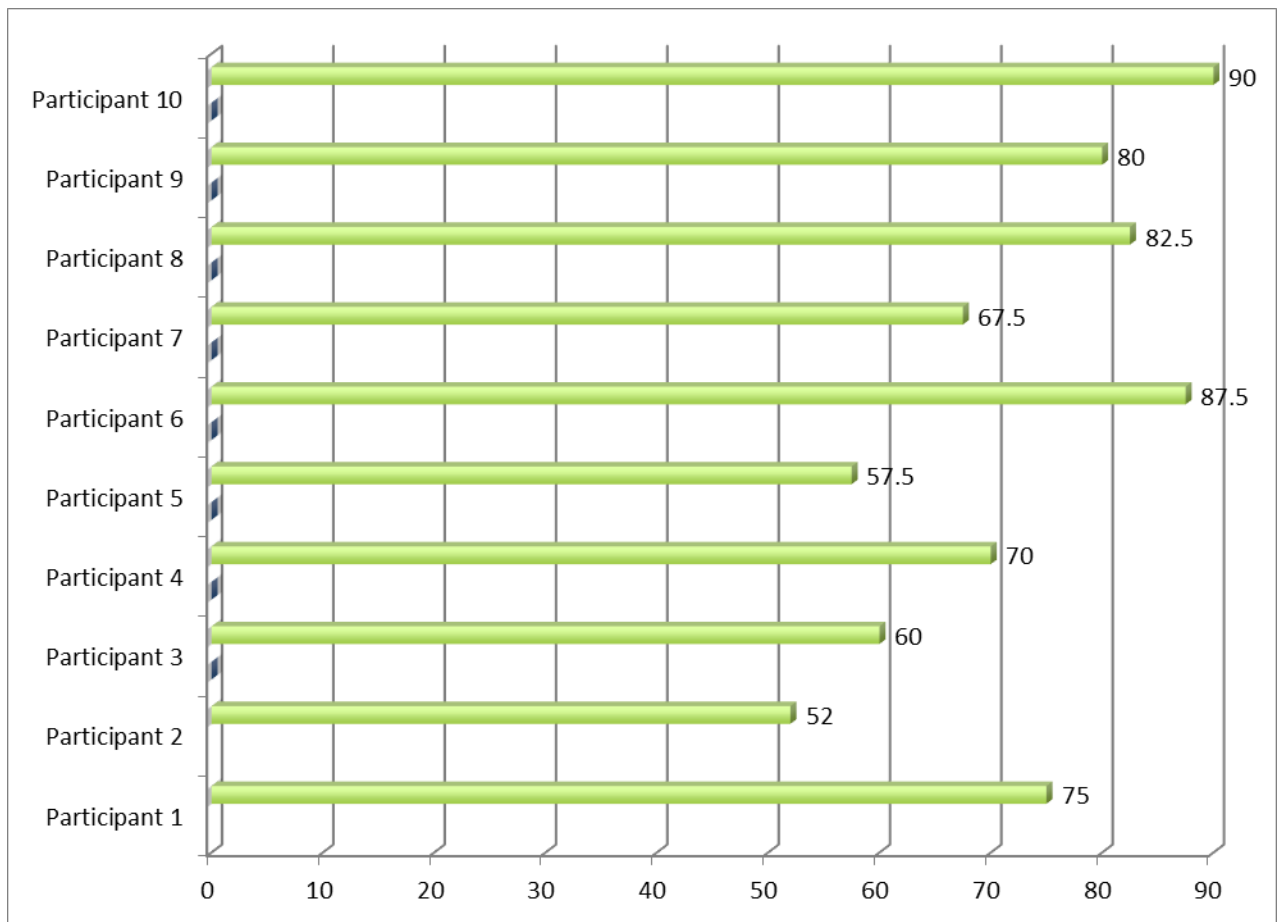
Again, the average overall task satisfaction rate was 4.37 out of 5.

System Usability Scale

The System Usability Scale (SUS) is a simple, 10-item Likert-type attitude scale providing a global subjective assessment of usability from the user's perspective (John Brooke at Digital Equipment Company developed the SUS in 1986). The SUS scale is scored from 0 to 100; scores under 60 represent systems with less-than-optimal usability, scores over 80 are considered better than average. See Appendix D for a copy of the SUS.

The mean SUS score of the Convergence Care EHR was seventy-two (72) and ranged from a low of fifty-two (52) and a high of ninety (90). Overall, participant-users rated their satisfaction with the Convergence Care software system to be a usable and somewhat satisfying EHR.

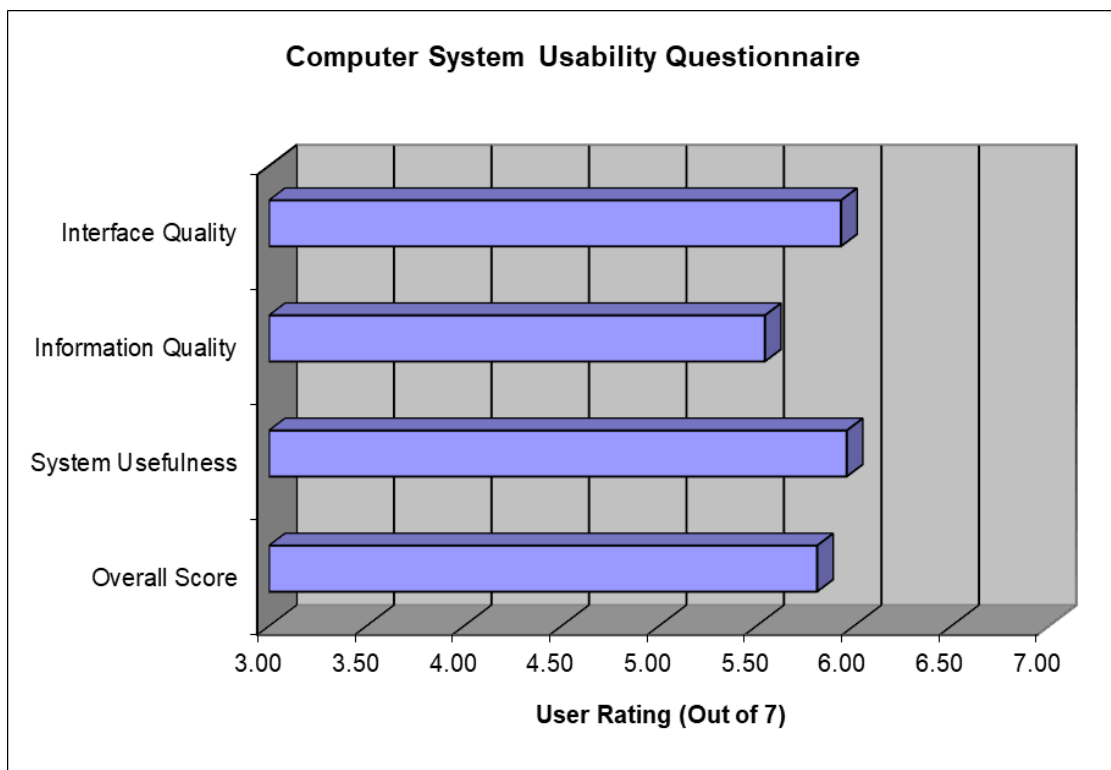
The following chart shows the SUS score by each participant:



Computer System Usability Questionnaire

Using the Computer System Usability Questionnaire (CSUQ; Lewis, J. R. (1995). (See: IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use. International Journal of Human-Computer Interaction, 7:1, 57-78).), participants rated each of 19 items of the CSUQ questionnaire on a scale from 1 to 7, with a rating of 7 being most in agreement with the positively-worded item. Responses for each item were summed and averaged to four scales – Interface Quality, Information Quality, System Usefulness- and an overall scale. See Appendix E for a copy of the CSUQ.

Figure 2 displays CUSQ ratings for each of the four scales. In general, participants in the Convergence Care study rated system usability to be high. On Interface Quality the average score for the participants was 5.54 (out of 7); on Information Quality the average score 5.93 (out of 7); on System Usefulness the average score was 5.96 (out of 7); and the overall average CUSQ score was 5.81 (out of 7).



Specific Task Result Details

Participant Number	Task 1 (a5) Demographics			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	2:35	Success	1	4
P02	4:29	Fail	7	3
P03	1:32	Success	0	5
P04	3:16	Success	3	4
P05	1:45	Success	1	4
P06	1:18	Success	0	4
P07	1:05	Success	1	5
P08	3:52	Success	4	3
P09	1:33	Success	0	4
P10	2:22	Success	0	4

Expected Time on Task	2:00	(SD)
Average Time on Task	2:09	1:06
Average Task Satisfaction	4.00	0.63
Average #Path Deviations	1.70	2.19
Percent Success	90%	

Participant Number	Task 2 (a5) Demographics - Modify			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	2:21	Success	3	5
P02	2:18	Success	3	4
P03	1:04	Success	0	4
P04	1:54	Success	0	5
P05	1:28	Success	0	5
P06	2:18	Success	2	5
P07	1:01	Success	0	5
P08	3:32	Success	2	4
P09	1:06	Success	0	4
P10	1:31	Success	1	4

Expected Time on Task	2:00	(SD)
Average Time on Task	1:51	0:45
Average Task Satisfaction	4.50	0.50
Average #Path Deviations	1.10	1.22
Percent Success	100%	

Participant Number	Task 3 (b.2) Clinical Info Reconciliation-Medications			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:08	Success	1	4
P02	2:23	Success	4	5
P03	1:43	Success	0	4
P04	1:53	Success	0	5
P05	1:58	Success	1	4
P06	2:12	Success	2	3
P07	1:37	Success	0	5
P08	3:01	Success	3	4
P09	1:41	Success	0	5
P10	2:24	Success	0	5

Expected Time on Task	1:30	(SD)
Average Time on Task	2:00	0:30
Average Task Satisfaction	4.40	0.66
Average #Path Deviations	1.10	1.37
Percent Success	100%	

Participant Number	Task 4 (b.2) Clinical Info Reconciliation--Allergy			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	2:21	Success	2	3
P02	1:28	Success	6	5
P03	1:22	Success	0	4
P04	1:05	Success	1	4
P05	1:41	Success	1	4
P06	1:57	Success	3	3
P07	1:24	Success	0	5
P08	1:11	Success	3	4
P09	1:22	Success	0	5
P10	1:37	Success	0	5

Expected Time on Task	1:00	(SD)
Average Time on Task	1:33	0:21
Average Task Satisfaction	4.20	0.75
Average #Path Deviations	1.60	1.85
Percent Success	100%	

Participant Number	Task 5 (b.2) Clinical Info Reconciliation--Diagnosis			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:06	Success	0	5
P02	0:54	Success	0	5
P03	1:19	Success	1	4
P04	1:26	Success	1	4
P05	1:03	Success	0	4
P06	0:57	Success	0	4
P07	1:01	Success	1	5
P08	0:55	Success	0	5
P09	1:20	Success	1	5
P10	1:01	Success	0	4

Expected Time on Task	1:00	(SD)
Average Time on Task	1:06	0:11
Average Task Satisfaction	4.50	0.50
Average #Path Deviations	0.40	0.49
Percent Success	100%	

Participant Number	Task 6 (a.14) Implantable Device List--Enter			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	0:21	Success	7	3
P02	4:08	Fail	7	3
P03	1:54	Success	1	4
P04	1:57	Success	1	3
P05	1:23	Success	0	4
P06	4:04	Fail	6	3
P07	1:11	Success	0	4
P08	3:58	Fail	8	3
P09	1:04	Success	0	4
P10	1:43	Success	2	4

Expected Time on Task	1:00	(SD)
Average Time on Task	1:22	1:19
Average Task Satisfaction	3.50	0.50
Average #Path Deviations	3.20	3.19
Percent Success	70%	

Participant Number	Task 7 (a.14) Implantable Device List--Modify			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:16	Success	0	5
P02	1:09	Fail	7	3
P03	0:53	Success	1	4
P04	0:38	Success	0	4
P05	0:45	Success	1	4
P06	2:18	Success	3	4
P07	0:41	Success	0	5
P08	0:39	Success	0	5
P09	0:55	Success	0	5
P10	1:41	Fail	6	3

Expected Time on Task	1:00	(SD)
Average Time on Task	1:01	0:31
Average Task Satisfaction	4.20	0.75
Average #Path Deviations	1.80	2.52
Percent Success	80%	

Participant Number	Task 8 (a.1) CPOE--Record medication			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:42	Success	0	5
P02	2:30	Fail	7	2
P03	0:45	Success	0	4
P04	0:59	Success	2	5
P05	1:27	Success	0	4
P06	1:41	Success	1	4
P07	0:50	Success	0	4
P08	1:22	Success	1	5
P09	1:18	Success	0	5
P10	0:51	Success	0	5

Expected Time on Task	1:30	(SD)
Average Time on Task	1:13	0:30
Average Task Satisfaction	4.30	0.90
Average #Path Deviations	1.10	2.07
Percent Success	90%	

Participant Number	Task 9 (a.9) Clinical Decision Support--View			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	3:36	Success	0	4
P02	2:25	Success	2	4
P03	1:41	Success	0	4
P04	1:39	Success	0	5
P05	1:19	Success	0	5
P06	1:14	Success	0	4
P07	1:50	Success	0	4
P08	2:59	Success	0	5
P09	1:04	Success	0	5
P10	2:53	Success	1	4

Expected Time on Task	1:00	(SD)
Average Time on Task	2:04	0:49
Average Task Satisfaction	4.4	0.49
Average #Path Deviations	0.30	0.64
Percent Success	100%	

Participant Number	Task 10 (a.1) CPOE Record medication--Modify			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	2:39	Success	2	5
P02	3:43	Fail	6	2
P03	2:22	Success	0	5
P04	2:09	Success	0	5
P05	2:16	Success	1	5
P06	1:59	Success	0	4
P07	2:01	Success	1	5
P08	3:11	Success	2	4
P09	1:57	Success	0	5
P10	3:03	Success	2	4

Expected Time on Task	2:00	(SD)
Average Time on Task	2:24	0:34
Average Task Satisfaction	4.4	0.92
Average #Path Deviations	1.4	1.74
Percent Success	90%	

Participant Number	Task 11 (a.9) Clinical Decision Support—Override			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	3:38	Success	0	4
P02	3:41	Success	2	4
P03	1:23	Success	0	5
P04	1:38	Success	0	5
P05	1:16	Success	0	5
P06	2:25	Success	2	4
P07	1:42	Success	1	5
P08	1:47	Success	1	5
P09	1:18	Success	0	5
P10	2:43	Success	2	5

Expected Time on Task	1:30	(SD)
Average Time on Task	2:09	0:52
Average Task Satisfaction	4.70	0.46
Average #Path Deviations	0.80	0.87
Percent Success	100%	

Participant Number	Task 12 (a.2) CPOE--Record Lab order			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:23	Success	1	5
P02	2:51	Fail	6	2
P03	0:12	Success	0	5
P04	0:58	Success	0	5
P05	1:02	Success	1	5
P06	1:36	Success	0	4
P07	1:26	Success	0	5
P08	1:34	Success	0	5
P09	1:38	Success	0	4
P10	1:28	Success	0	5

Expected Time on Task	1:00	(SD)
Average Time on Task	1:15	0:38
Average Task Satisfaction	4.50	0.92
Average #Path Deviations	0.80	1.78
Percent Success	90%	

Participant Number	Task 13 (a.2) CPOE--Modify Lab order			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	0:47	Success	2	5
P02	2:08	Success	3	4
P03	1:18	Success	0	4
P04	1:42	Success	0	5
P05	1:01	Success	0	4
P06	2:11	Success	2	4
P07	2:02	Success	0	5
P08	1:43	Success	0	4
P09	1:36	Success	0	5
P10	1:14	Success	0	5

Expected Time on Task	1:30	(SD)
Average Time on Task	1:34	0:27
Average Task Satisfaction	4.50	0.50
Average #Path Deviations	0.70	1.10
Percent Success	100%	

Participant Number	Task 14 (a.4) Drug-drug interaction check			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:11	Success	0	5
P02	1:16	Success	0	5
P03	1:22	Success	0	5
P04	1:12	Success	0	5
P05	1:06	Success	0	5
P06	1:41	Success	2	4
P07	1:08	Success	0	5
P08	1:14	Success	0	4
P09	1:15	Success	0	5
P10	1:29	Success	0	5

Expected Time on Task	1:00	(SD)
Average Time on Task	1:17	0:10
Average Task Satisfaction	4.80	0.40
Average #Path Deviations	0.20	0.60
Percent Success	100%	

Participant Number	Task 15 (a.4) Drug-allergy interaction check			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:49	Success	0	4
P02	2:18	Success	2	3
P03	1:50	Success	0	4
P04	2:09	Success	0	5
P05	1:35	Success	0	4
P06	1:29	Success	1	3
P07	1:53	Success	0	5
P08	2:31	Success	1	5
P09	1:46	Success	0	5
P10	1:20	Success	1	4

Expected Time on Task	1:30	(SD)
Average Time on Task	1:52	0:21
Average Task Satisfaction	4.20	0.75
Average #Path Deviations	0.50	0.67
Percent Success	100%	

Participant Number	Task 16 (b.2) Clinical Info Reconciliation—View data			
	Task Time	Outcome	# Path Deviations	Task Satisfaction
P01	1:49	Success	0	5
P02	1:18	Success	2	5
P03	0:35	Success	0	5
P04	1:19	Success	0	5
P05	1:15	Success	0	5
P06	1:59	Success	1	4
P07	0:53	Success	0	5
P08	1:12	Success	0	4
P09	1:54	Success	0	5
P10	1:41	Success	1	5

Expected Time on Task	1:00	(SD)
Average Time on Task	1:23	0:26
Average Task Satisfaction	4.80	0.40
Average #Path Deviations	0.40	0.66
Percent Success	100%	

Discussion of Findings

In general, the participants performed well and were satisfied with Convergence Care EHR system. Some participants struggled with some portions of a few tasks but in general most were able to successfully complete a large majority of the tasks with little or no difficulty. Given that no participants had any prior experience with the system, this shows that the Convergence Care EHR is a fairly easy-to-learn EHR. Participants were mostly able to perform all tasks successfully on their own with no assistance or external documentation. The participant average performance rate was high. The Convergence Care system appears to be a usable EHR.

Effectiveness

Of the sixteen (16) tasks presented, a large majority of the tasks were successfully completed by all of the participants. Over all of participants, the mean successful task completion rate was high with an overall average rate of ninety-four (94) percent indicating that in general the participants had little difficulty completing the tasks.

The amount of prior experience with EHR systems was related to successful task performance and error rates; participants with more prior experience seemed to be more slightly likely to successfully complete tasks with less errors than those with less prior experience.

Efficiency

Participants who successfully completed tasks generally completed those tasks within an acceptable time. Some tasks were completed more quickly than the calculated optimal time, while several tasks took slightly longer than expected. The tasks that took the longest required the participants to navigate to an unfamiliar portion of a page, interact with a workflow, locate and select specific actions. Those tasks may be performed more quickly with a minor set of updates to the user interface and/or the user experience.

Some participants made errors when attempting to navigate toward solving their assigned tasks. These errors may be associated with those participants not being familiar with features and

not understanding the menus and the information architecture of the Convergence Care software system. As noted above, prior experience with EHR systems was related to successful task completion.

Satisfaction

Participants were satisfied with the Convergence Care system; ratings on the SUS (mean = 72 out of a possible 100) and the CSUQ (Overall score = 5.81 out of a possible 7.0) demonstrated a sizable degree of satisfaction with the system.

On the CSUQ, participants ranked the scale "(System Usefulness)" highest of the three scales, suggesting that users felt that the system would likely solve their tasks in an effective and efficient manner. Individual task satisfaction ratings were related to individual user performance. Those participants who were able to successfully complete tasks were also more likely to rank those tasks as satisfying, while those participants who did poorly or were not able to complete a task ranked those tasks as less satisfying.

Summary of Major Findings

This evaluation demonstrated that the Convergence Care EHR system is a usable system with a short learning curve. Participants with no experience using the system experienced little difficulty completing their tasks, even with a limited understanding the overall navigation and information architecture. Participants with more EHR experience were slightly more able to solve most tasks without difficulty or error.

Risk Analysis

The following table presents a list of tasks presented with the risk of error as observed during the testing.

Table 5. Risk Analysis

Task	Description	Percent Complete	Risk Status
Task 1 (a5) Demographics	Verify and Enter Demographic Information	90%	Low
Task 2 (a5) Demographics - Modify	Modify Demographic Information	100%	None
Task 3 (b.2) Clinical Info Reconciliation-Medications	Incorporate a CCDA file-Meds	100%	None
Task 4 (b.2) Clinical Info Reconciliation--Allergy	Incorporate a CCDA file-Allergy	100%	None
Task 5 (b.2) Clinical Info Reconciliation--Diagnosis	Incorporate a CCDA file-Diagnosis	100%	None
Task 6 (a.14) Implantable Device List--Enter	Add an item to the implantable device list	70%	Moderate
Task 7 (a.14) Implantable Device List--Modify	Modify an item in the implantable device list	80%	Low
Task 8 (a.1) CPOE--Record medication	Record a medication order	90%	Low
Task 9 (a.9) Clinical Decision Support--View	View decision support information	100%	None
Task 10 (a.1) CPOE Record medication--Modify	Modify a medication order	90%	None
Task 11 (a.9) Clinical Decision Support—Override	Override decision support information	100%	Low
Task 12 (a.2) CPOE--Record Lab order	Record a lab order	90%	Low
Task 13 (a.2) CPOE--Modify Lab order	Modify a lab order	100%	None
Task 14 (a.4) Drug-drug interaction check	View Information for drug interaction	100%	None
Task 15 (a.4) Drug-allergy interaction check	View Information for allergy interaction	100%	None
Task 16 (b.2) Clinical Info Reconciliation—View data	View/Export reconciled data	100%	None

Areas for Improvement

The following is a partial list of potential areas for improvement.

Making these and other minor enhancements will improve the overall user experience of the Convergence Care system and increase the effectiveness, efficiency, and satisfaction for both experienced and novice users.

- **Inconsistent User Interface**
 - Several participants commented that sometimes the interface presented a feature or function that did not exactly match their expectations. Creating a visual and textual information that is consistent across all functional areas would help to improve the overall user experience of the system.
 - The system provided great feedback to the users, but this feedback was presented in an inconsistent manner.

- **Some features and functions had a different “look and feel”**
 - Some feature and functions seem to work different than the rest of the application. These features had a different user experience than the majority of the Convergence Care system, and may have led to reduced performance and satisfaction scores.

Appendices

Appendix A: Recruiting Screener

1. Are you male or female?
2. Have you participated in a focus group or usability test in the past 6 months?
3. Do you, or does anyone in your home work in marketing research, usability research, and/or web design?
4. Do you, or does anyone in your home, have a commercial or research interest in an electronic health record software or consulting company?
5. Which of the following best describes your age?

20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89, 90-99, 100 and older.
6. Which of the following best describes your education level?
 - No high school diploma
 - High school graduate, diploma or the equivalent
 - Some college credit, no degree
 - Trade technical vocational training
 - Associate degree
 - Bachelor's degree
 - Master's degree
 - Doctorate degree (e.g., MD, DNP, DMD, PhD)
7. Do you require any assistive technologies to use a computer?
8. Please describe your medical or nursing credentials
9. What is your current job title?
10. How long have you held this position? (Number of years):
11. What type of facility do you work in and what is your role there?
12. How are medical records handled at your (main) workplace?

All Paper Some Paper/Some Electronic All Electronic
13. How many EHRs do you use or have you worked with?
14. How many years have you used an electronic health record?
15. How many years have you used the Convergence Care system?

16. How many years have you used computers?

17. About how many hours per week do you spend using a computer?

18. What computer platform(s) do you usually use?

19. In the last month, about how often have you used an electronic health record?

Did not use last month

Every day

A few times a week.

Appendix B: Informed Consent Form

The Usability People would like to thank you for participating in this study. The purpose of this study is to evaluate an electronic health records system. If you decide to participate, you will be asked to perform several tasks using the prototype and give your feedback. The study will last about 45 minutes.

Agreement

I understand and agree that as a voluntary participant in the present study conducted by The Usability People. I am free to withdraw consent or discontinue participation at any time. I understand and agree to participate in the study conducted and recorded by The Usability People.

I understand and agree that the purpose of this study is to make software applications more useful and usable in the future.

I understand and agree that the data collected from this study may be shared outside of The Usability People. I understand and agree that data confidentiality is assured, because only de-identified data – i.e., identification numbers not names – will be used in analysis and reporting of the results.

I agree to immediately raise any concerns or areas of discomfort with the study administrator. I understand that I can leave at any time.

Please check one of the following:

YES, I have read the above statement and agree to be a participant.

NO, I choose not to participate in this study.

Signature: _____ **Date** _____

Appendix C: Participant Guide

ORIENTATION and INTRODUCTION

Thank you for participating in this study. The session today will last approximately 45 minutes. During this session, you will look at a version of the Convergence EHR. The product you will be using today may not be exactly like any of the software that you may be used to. Some of the data may not make perfect sense, as the screens that you shall interact with contain mostly placeholder data.

The purpose of this study is to gauge the usability of the software. We are interested in how easy (or how difficult) this version is to use, and learning about which of the features and benefits would be most useful to you. We also want to know how we could improve it.

The moderator will guide you through the testing process. Please use the software as you would in a real clinical setting. You will be asked to save your comments until the end of a task or the end of the session to discuss your thoughts freely.

Here are some things you should know about your participation in this session

- The Moderator will guide you through each task.
- Please do not work ahead.
- If you notice an error, just cancel out and continue to the task. If you feel lost or have difficulty completing the scenario, please inform the Moderator.
- All information will be kept confidential. Your name will not be associated with your comments at any time.

Fictitious patient scenarios have been created and pre-loaded in the system software. The Moderator will ask you to complete several tasks using the system. You will be asked to answer some questions and to complete some tasks on your own. Try to complete tasks as quickly as possible, with the fewest possible errors or deviations.

Please do not do anything more than asked.

Your patient **Francis Bacon** was recently admitted to your area.

They have been referred to your organization by an outside primary care facility. Before beginning to treat the patient, first you need to take care of some “paperwork”

Task 1 (a.5) Demographics

Before your encounter, first you need to verify or enter some of the demographic information that is stored within the system:

Sex assigned at birth	'Male'
Gender Identity	'Male'
Race	'Black or African American'
Ethnic Group	'Not Hispanic or Latino'
Sexual Orientation	'Heterosexual'
Preferred Language	'Decline to specify'

Verify and/or enter and save this information into the EHR. Verify that any changes are saved.

Task 2 (a.5) Demographics - Modifications

During your consultation with the patient, they ask you to make the following additional changes to their demographic records:

Date of Birth	'07/13/1944'
Gender Identity	'Genderqueer, neither Male nor Female'
Race	'Asian'
Ethnic Group	'Not Hispanic or Latino'
Sexual Orientation	'Decline to Specify'
Preferred Language	'English'

Verify and/or enter and save this information into the EHR. Verify that any changes are saved.

Your patient was been admitted as referral from another provider. This provider has electronically transmitted the appropriate medical information via an electronic CCDa document.

For your convenience the document has already been loaded into the system. However, before you continue with the patient, first you need to reconcile and incorporate the Medications, Diagnoses and Allergies information, from the other provider into the patient's existing records.

Task 3 (b.2) Clinical Information Reconciliation and Incorporation--Medications

Locate the Medical list Reconciliation feature and:

Place a lock on the patient's profile before you begin to:

Ensure that **Lipitor 10mg oral tabs** is among the Final Reconciled Medications.
Ensure that **Prozac 10 mg** is part of the Final Reconciled Medications.

Review and save this information into the EHR. Verify that it has been saved.

Task 4 (b.2) Clinical Information Reconciliation and Incorporation—Allergy

Locate the Allergies Reconciliation feature and:

Ensure that the **Sulfonamide Antibiotics** allergy is part of the Final Reconciled Allergy List.
Ensure that the **Ampicillin** allergy is part of the Final Reconciled Allergy List.

Review and save this information into the EHR. Verify that it has been saved.

Task 5 (b.2) Clinical Information Reconciliation and Incorporation--Diagnosis

Locate the Diagnosis Reconciliation feature and:

Ensure that the **Tennis Toe** (disorder) is included in the Final Reconciled Problem List.
Ensure that **Fever** (finding) is included in the Final Reconciled Problem List.

Review and save this information into the EHR. Verify that it has been saved.

Task 6 (a.14) Implantable Device List--Enter

The client claims that they have an implanted device (a pacemaker) but they are unsure about the details of the device.

Add a new implanted device with the following settings:

Implantable device present: **Unknown**
Name of Device: **Pacemaker**

Enter and save this information into the EHR.

Task 7 (a14) Implantable Device List--Modify

The patient later says that they have a card in their wallet with a barcode that contains the details of their implantable device.

Upon viewing the card, you notice the following as a barcode on the card:

(01)10884521062856(11)141231(17)150707(10)A213B1(21)1234

(This UDI/GS1 number should be in your 'clipboard' and a copy has been saved as a txt file in your desktop).

Modify the implanted device with the following settings:

Implantable device present: **Yes**
Name of Device: **Pacemaker**
GS1: **(Enter the UDI # above)**

Enter and save this information into the EHR. And verbally state the device description, identifiers, and key attributes of this device as presented on the screen

Task 8 (a.1) CPOE--Record medication

Your patient requests a Tylenol for some pain that they have been feeling in their left elbow. View the patient's current medication list and add the following medication:

Tylenol 325 mg tablet oral once every 4 hours. (Sig/Freq: **4P**)

Indication: "**As needed for pain**" or "**Pain**"

Enter and save this information into the EHR.

Task 9 (a.9) Clinical Decision Support--View

As you enter this medication order, the Clinical Decision Support system will display a number of warning messages.

View the details of each of these warnings.

Task 10 (a.1) CPOE Record medication--Modify

Upon further conversation with the patient, you decide to not give them Tylenol but instead provide Aleve (Naproxen Sodium). Change the medication order from above so that Aleve is listed in the medication list.

Naproxen Sodium 250 MG tablet once every 8 hours (Sig/Freq: **8P**)

Indication: '**Left Elbow pain**' or just '**Pain**'

Enter and save this information into the EHR. Verify that the changes have been saved.

Task 11 (a.9) Clinical Decision Support—Override

As you enter this medication order, the Clinical Decision Support system will again display a number of warnings.

View the details of each of these warnings

Override these warnings and **save** the medication order

Verify that the medication order has been placed.

Due to the global corona virus pandemic, every patient must be testing for Covid-19

Task 12 (a.2) CPOE- Record Lab order

Add a new Lab request for the lab test described below:

Search for and select the following lab test:

- **Covid-19 PCR**

Place this order, using the following information:

Ordering Dept: **'MU3'**

Reason: **'Pandemic'**

Enter and save this lab request into the EHR. Verify that any changes have been saved.

Task 13 (a.2) CPOE--Modify Lab order

Upon reviewing the lab order just entered, you realize you would also like to run a Covid Antibody test

Modify the order so that both the **Covid-19 PCR** and **Covid-19 Antibody** tests are ordered

Remember to use the following information:

Ordering Dept: **'MU3'**

Reason: **'Pandemic'**

Enter and save this information into the EHR. Verify that the changes have been saved.

Task 14 (a.4) Drug-drug interaction check

Upon evaluation of their vital signs, you determine that your patient has hypertension. You want to provide a medication to help treat their high blood pressure.

Begin to add an order for '**Lisinopril 5mg Tablet**'

The system will immediately display a warning message(s) regarding this new medication.

Review the **Drug-drug interaction** warning details.

DO NOT continue with this medication. Verify that no changes have been made.

Task 15 (a.4) Drug-allergy interaction check

The patient presents with infected sores on their left forearm. You want to provide an antibiotic to help treat these sores.

Begin to add an order for: '**Bactrim SS**'

The system will immediately display an **Allergy/Sensitivity** warning message(s) regarding this new medication.

Review the Allergy/Sensitivity interactions warning details.

DO NOT continue with this medication. Verify that no changes have been made.

Task 16 (b.2) Clinical Info Reconciliation—View data

You have completed your encounter with the patient. Before you leave the patient, you would like to create a fully up-to-date continuity of care document that includes the result of today's visit.

Locate the function to provide **Patient Reports** as **Printable Documents**

Create an electronic **CCD PDF** for your patient.

View the PDF that was created and note that it contains a full record of your encounter.

Appendix D: System Usability Scale Questionnaire

	1	2	3	4	5
1. I think that I would like to use this system frequently					
2. I found the system unnecessarily complex					
3. I thought the system was easy to use					
4. I think that I would need the support of a technical person to be able to use this system					
5. I found the various functions in this system were well integrated					
6. I thought there was too much inconsistency in this system					
7. I would imagine that most people would learn to use this system very quickly					
8. I found the system very cumbersome to use					
9. I felt very confident using the system					
10. I needed to learn a lot of things before I could get going with this system					

Appendix E: Computer System Usability Questionnaire

Please provide your impression of the usability of the system by answering each of the questions below:

1. Overall, I am satisfied with how easy it is to use this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

2. It was simple to use this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

3. I can effectively complete my work using this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

4. I am able to complete my work quickly using this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

5. I am able to efficiently complete my work using this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

6. I feel comfortable using this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

7. It was easy to learn to use this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

8. I believe I became productive quickly using this system

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

9. The system gives error messages that clearly tell me how to fix problems

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

10. Whenever I make a mistake using the system, I recover easily and quickly

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

11. The information (such as online help, on-screen messages, and other documentation) provided with this system is clear

Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

12. It is easy to find the information I needed
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

13. The information provided for the system is easy to understand
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

14. The information is effective in helping me complete the tasks and scenarios
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

15. The organization of information on the system screens is clear
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

16. The interface of this system is pleasant
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

17. I like using the interface of this system
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

18. This system has all the functions and capabilities I expect it to have
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

19. Overall, I am satisfied with this system
Strongly 1 2 3 4 5 6 7 NA Strongly
Disagree Agree

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