

EHR Usability Test Report for RevolutionEHR version 7

Report based on ISO/IEC 25062:2006 Common Industry Format for Usability Test Reports

RevolutionEHR version 7

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Executive Summary

A usability test of RevolutionEHR version 7 was conducted in September 2018 via remote testing by an internal team. The purpose of this test was to test and validate the usability of the current user interface, and provide evidence of usability in RevolutionEHR. During the usability test, 10 eye care providers and staff members matching the target demographic criteria served as participants and used RevolutionEHR in simulated, but representative tasks.

This study collected performance data on 34 tasks that align with those 2015 Edition certification criteria for which RevolutionEHR is seeking certification:

- (a1) CPOE for Medication Orders
 - Record medication via CPOE
 - Change medication via CPOE
 - Display changed CPOE medication order
- (a2) CPOE for Laboratory Test Orders
 - Record laboratory test order via CPOE
 - Change laboratory test order via CPOE
 - Display changed laboratory test order
- (a3) CPOE for Diagnostic Imaging Orders
 - Record diagnostic imaging order via CPOE
 - Change diagnostic imaging order via CPOE
 - Display changed diagnostic imaging
- (a5) Demographics
 - Record a patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity
 - Change the patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity
 - Display the patient's changed preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity
- (a6) Problem List
 - Record a problem to the problem list
 - Change a problem on the problem list
 - Display the active problem list
 - Display the historical problem list
- (a7) Medication List
 - Record a medication to the medication list
 - Change a medication on the medication list
 - Display the active medication list
 - Display the historical medication list
- (a8) Medication Allergy List
 - Record a medication allergy

- Change a medication allergy
 - Display the active medication allergy list
 - Display the historical medication allergy list
- (a9) Clinical Decision Support
 - Add a CDS intervention and/or reference resource for each of the required elements
 - Problem list
 - Medication list
 - Medication Allergy List
 - At least one Demographic
 - Laboratory Test
 - Vital Signs
 - And a combination of at least 2 of the elements listed above
 - Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements
 - View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics
 - Trigger the CDS interventions/resources based on data elements in the problem list, medication list, and medication allergy list by incorporating patient information from a transition of care/referral summary
 - Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date
- (a14) Implantable Device List
 - Record UDI
 - Change UDI Status
 - Access UDI, device description, identifiers, and attributes
- (b2) Clinical Information Reconciliation and Incorporation
 - Incorporate a CCDA and conduct reconciliation of the medications, medication allergies, and problems in the CCDA with the information currently in the patient's record
 - Generate a new CCDA with reconciled data

Prior to test performance, each user task was ranked based on perceived /projected risk to the patient if an error occurred preventing proper completion. We employed a three-tier risk ranking system (high, medium, low) to categorize those risk levels and the table below summarizes that work:

Task Risk Grouping	
HIGH RISK TASKS	
a1-1:	Record medication via CPOE
a1-2:	Change medication via CPOE
a6-1:	Record a problem to the problem list
a6-2:	Change a problem on the problem list
a7-1:	Record a medication to the medication list
a7-2:	Change a medication on the medication list
a8-1:	Record a medication allergy
a8-2:	Change a medication allergy
MEDIUM RISK TASKS	
a1-3:	Display changed CPOE medication order
a2-1:	Record laboratory test order via CPOE
a2-2:	Change laboratory test order via CPOE
a3-1:	Record diagnostic imaging order via CPOE
a3-2:	Change diagnostic imaging order via CPOE
a5-1:	Record a patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity
a6-3:	Display the active problem list
a6-3:	Display the historical problem list
a7-3:	Display the active medication list
a7-4:	Display the historical medication list
a8-3:	Display the active medication allergy list
a8-4:	Display the historical medication allergy list
a9-4:	Trigger the CDS interventions/resources based on data elements in the problem list, medication list, and medication allergy list by incorporating patient information from a transition of care/referral summary
b2-1:	Incorporate a CCDA and conduct reconciliation of the medications, medication allergies, and problems in the CCDA with the information currently in the patient's record
b2-2:	Generate a new CCDA with reconciled data
LOW RISK TASKS	
a2-3:	Display changed CPOE laboratory test order
a3-3:	Display changed CPOE diagnostic imaging test order
a5-3:	Display the patient's changed preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity
a5-2:	Change the patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity
a9-1:	Add a CDS intervention and/or reference resource for each of the required elements
a9-2:	Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements
a9-3:	View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics
a9-5:	Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date
a14-1:	Record UDI
a14-2:	Change UDI Status
a14-3:	Access UDI, device description, identifiers, and attributes

During the usability test, each participant was greeted and instructed that they could withdraw at any time. Participants had prior experience with the EHR. The administrator introduced the test and instructed participants to complete a series of tasks (given one at a time) using RevolutionEHR. During the testing, the administrator timed the test and recorded user performance data on paper and electronically. The administrator did not give the participant assistance in how to complete the task.

The following types of data were collected for each participant:

- Number of tasks successfully completed within the allotted time without assistance
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant’s verbalizations
- Participant’s satisfaction ratings of the system

All participant data was de-identified for analysis.

Following testing, participants were asked to complete a post-test survey and were not compensated for their time. Various recommended metrics, in accordance with the examples set forth in the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records*, were used to evaluate the usability of RevolutionEHR. Following is a summary of the performance and rating data collected on RevolutionEHR.

Task	N	Task Success	Path Deviation	Task Time		Errors	Task Rating 5 = Easy
	#	Mean (SD)	Deviations (Observed / Optimal)	Mean (SD)	Deviations (Observed / Optimal)	Mean (SD)	Mean (SD)
a1-1: Record medication via CPOE	10	100% (0%)	6.5 / 6	37 sec (8)	37 / 30	0% (0%)	3.7 (1)
a1-2: Change medication via CPOE	10	100% (0%)	4.5 / 4	25 sec (5)	25 / 24	0% (0%)	4.5 (0)
a1-3: Display changed CPOE medication order	10	100% (0%)	3.2 / 3	10 sec (3)	10 / 8	0% (0%)	5.0 (0)
a2-1: Record laboratory test order via CPOE	10	100% (0%)	5.8 / 5	28 sec (3)	28 / 25	0% (0%)	3.5 (1)
a2-2: Change laboratory test order via CPOE	10	100% (0%)	4.0 / 4	24 sec (5)	24 / 24	0% (0%)	4.5 (0)
a2-3: Display changed CPOE laboratory test order	10	100% (0%)	3.1 / 3	9 sec (2)	9 / 8	0% (0%)	5.0 (0)
a3-1: Record diagnostic imaging order via CPOE	10	100% (0%)	5.9 / 5	25 sec (2)	25 / 25	0% (0%)	3.5 (1)
a3-2: Change diagnostic imaging order via CPOE	10	100% (0%)	4.0 / 4	24 sec (5)	24 / 24	0% (0%)	5.0 (0)
a3-3: Display changed CPOE diagnostic imaging test order	10	100% (0%)	3.2 / 3	10 sec (2)	10 / 8	0% (0%)	5.0 (0)



a5-1: Record a patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity	10	100% (0%)	8.2 / 8	15 sec (3)	15 / 15	0% (0%)	4.9 (0)
a5-2: Change the patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity	10	100% (0%)	3.0 / 3	4 sec (4)	4 / 4	0% (0%)	5.0 (0)
a5-3: Display the patient's changed preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity	10	100% (0%)	3.1 / 3	9 sec (1)	9 / 8	0% (0%)	5.0 (0)
a6-1: Record a problem to the problem list	10	100% (0%)	1.1 / 1	5 sec (0)	5 / 5	0% (0%)	4.9 (0)
a6-2: Change a problem on the problem list	10	100% (0%)	4.1 / 3	13 sec (1)	13 / 12	0% (0%)	4.3 (1)
a6-3: Display the active problem list	10	100% (0%)	3.3 / 3	11 sec (1)	11 / 10	0% (0%)	5.0 (0)
a6-4: Display the historical problem list	10	100% (0%)	2.0 / 1	5 sec (3)	5 / 3	0% (0%)	4.5 (1)
a7-1: Record a medication to the medication list	10	100% (0%)	1.3 / 1	8 sec (0)	8 / 8	0% (0%)	4.9 (0)
a7-2: Change a medication on the medication list	10	100% (0%)	6.4 / 6	31 Sec (2)	31 / 30	0% (0%)	4.1 (0)
a7-3: Display the active medication list	10	100% (0%)	4.4 / 4	10 sec (1)	10 / 10	0% (0%)	5.0 (0)
a7-4: Display the historical medication list	10	100% (0%)	2.0 / 1	5 sec (3)	5 / 3	0% (0%)	4.5 (1)
a8-1: Record a medication allergy	10	100% (0%)	1.4 / 1	8 sec (1)	8 / 8	0% (0%)	4.9 (0)
a8-2: Change a medication allergy	10	100% (0%)	3.2 / 3	12 sec (0)	12 / 12	0% (0%)	4.1 (0)
a8-3: Display the active medication allergy list	10	100% (0%)	2.1 / 2	10 sec (0)	10 / 10	0% (0%)	5.0 (0)
a8-4: Display the historical medication allergy list	10	100% (0%)	2.0 / 1	5 sec (2)	5 / 3	0% (0%)	4.5 (1)
a9-1: Add a CDS intervention and/or reference resource for each of the required elements	10	80% (42%)	10.0 / 3	30 sec (11)	30 / 15	20% (42%)	3.2 (1)
a9-2: Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements	10	100% (0%)	12.9 / 10	25 sec (10)	25 / 20	0% (0%)	3.0 (1)
a9-3: View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics	10	100% (0%)	2.2 / 2	10 sec (2)	10 / 10	0% (0%)	4.4 (0)
a9-4: Trigger the CDS interventions/resources based on data elements in the problem list, medication list, and medication allergy list by incorporating patient information from a transition of care/referral summary	10	100% (0%)	15 / 10	25 sec (10)	25 / 20	0% (0%)	3.0 (1)
a9-5: Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date	10	100% (0%)	2.5 / 2	9 sec (1)	9 / 9	0% (0%)	4.5 (0)

a14-1: Record UDI	10	90% (32%)	7.5 / 4	223 sec (71)	223 / 120	10% (32%)	2.0 (1)
a14-2: Change UDI Status	10	100% (0%)	3.5 / 3	10 sec (1)	10 / 7	0% (0%)	4.5 (1)
a14-3: Access UDI, device description, identifiers, and attributes	10	100% (0%)	3.1 / 3	10 sec (0)	10 / 10	0% (0%)	4.5 (0)
b2-1: Incorporate a CCDA and conduct reconciliation of the medications, medication allergies, and problems in the CCDA with the information currently in the patient's record	10	100% (0%)	4.6 / 4	32 sec (4)	32 / 30	0% (0%)	3.7 (1)
b2-2: Generate a new CCDA with reconciled data	10	100% (0%)	2.6 / 2	30 sec (6)	30 / 25	0% (0%)	4.4 (1)

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be 81.5. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

In addition to the performance data, the following qualitative observations were made:

Major findings

- Unique device identifier (UDI) entry, while not complicated or difficult, was tedious for participants
- Clinical decision support rule setup was challenging to find

Areas for improvement

- Consider addition of barcode scanning abilities to Implantable Device list for more efficient logging of UDIs and devices
- Consider moving clinical decision support configuration to an easier-to-find position

Introduction

The EHRUT(s) tested for this study was RevolutionEHR version 7. Designed to present medical information to healthcare providers in eye care, the EHRUT consists of a web-based, browser-accessed internet application. The usability testing attempted to represent realistic activities that a participant would engage in on a regular basis.

The purpose of this study was to test and validate the usability of the current user interface and provide evidence of usability in the EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency and user satisfaction, such as task success, task failures, and task time were captured during the usability testing.

Method

PARTICIPANTS

A total of 10 participants were tested on the EHRUT. Participants in the test were optometrists and associated staff members (i.e. technicians, opticians, receptionists). Participants were recruited by RevolutionEHR and were not compensated for their time. In addition, participants had no direct connection to the development of or organization producing the EHRUT. Participants were not from the testing or supplier organization. Participants were given the opportunity to have the same orientation and level of training as the actual end users would have received.

For the test purposes, end-user characteristics were identified and translated into a recruitment screener used to solicit potential participants.

Recruited participants had a mix of backgrounds and demographic characteristics conforming to the recruitment screener. The following is a table of participants by characteristics, including demographics, professional experience, computing experience and user needs for assistive technology. Participant names were replaced with Participant IDs so that an individual's data cannot be tied back to individual identities.



	Participant ID	Gender	Age	Education	Occupation / Role	Professional Experience (months)	Computer Experience (months)	Product Experience (months)	Assistive Technology Needs
1	ID01	M	69	Doctorate	OD	600	300	50	No
2	ID02	F	65	Trade / technical / vocational	Optician	420	240	52	No
3	ID03	F	50	High School Graduate	Technician	144	250	120	No
4	ID04	F	40	Some college credit, no degree	Receptionist	60	120	60	No
5	ID05	M	42	Doctorate	OD	180	340	186	No
6	ID06	F	54	Bachelor's Degree	Receptionist	96	200	98	No
7	ID07	F	42	Bachelor's Degree	Technician	84	240	48	No
8	ID08	M	38	Bachelor's Degree	Optician	62	260	12	No
9	ID09	M	45	Doctorate	OD	175	330	36	No
10	ID10	M	50	Doctorate	OD	240	310	6	No

10 participants were recruited and 10 participated in the usability test. 0 participants failed to show for the study.

Participants were scheduled for virtual sessions with the administrator. Participant activities were monitored through web-based tools and post-test impressions through survey.

STUDY DESIGN

Overall, the objective of this test was to uncover areas where the application performed well – that is, effectively, efficiently, and with satisfaction – and areas where the application failed to meet the needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same EHR and/or comparison with other EHRs provided the same tasks are used. In short, this testing serves as both a means to record or benchmark current usability, but also to identify areas where improvements must be made.

During the usability test, participants interacted with an identical version of one EHR: RevolutionEHR version 7. Each participant used the system remotely via web access and was provided with the same instructions. The system was evaluated for effectiveness, efficiency and satisfaction as defined by measures collected and analyzed for each participant:

- Number of tasks successfully completed within the allotted time without assistance
- Time to complete the tasks
- Number of errors
- Path deviations
- Participant’s verbalizations/comments
- Participant’s satisfaction ratings of the system

Additional information about the various measures can be found in the Data Scoring section beginning on page 16.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, including:

- Computerized Provider Order Entry (CPOE)
- Entering a patient’s Demographics
- Reviewing a patient’s Problem List, Medication List, and Medication Allergy List
- Configuring Clinical Decision Support rules
- Adding an Implantable Device to a patient’s record
- Reconciling clinical information from another provider

The tasks were specifically selected based on their alignment with 2015 Edition CEHRT criteria for which RevolutionEHR sought certification as well as Drummond Group requirements as noted in version 1.1 of the proctor sheet for (g3). The tasks were prioritized on their frequency of use, criticality of function, and those that may be most troublesome for users. Tasks were constructed in light of the study objectives.

PROCEDURES

On test day, participants were invited to a virtual meeting (GoToMeeting) and asked to enable their web camera. On arrival, the participant's name was matched with a name on the participant schedule. Participants were then assigned a participant ID.

The administrator moderated the session including administering instructions and tasks. The administrator also monitored task times, obtained post-task rating data, and took notes on participant comments.

Participants were instructed to perform the tasks:

- As quickly as possible making as few errors and deviations as possible.
- Without assistance (the administrator could provide clarification on tasks, but not instructions on use).
- Without using a think aloud technique.

For each task, the participants were read the task as they followed along with a text copy on the screen. Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated they had successfully completed the task. Scoring is discussed in the Results section beginning on page 16.

Following the session, the administrator gave the participant the post-test survey and thanked each individual for their participation.

Participants' demographic information, task success rate, time on task, errors, deviations, and post-test survey responses were recorded into a spreadsheet.

TEST LOCATION AND ENVIRONMENT

All participants performed the testing online from whatever traditional access system they otherwise use for performance of the technology. The test was performed with simulation of the same activity that participants typically use in their practice. Standard display of RevolutionEHR which is controlled by the browser display was rendered to the users identically. Participants were advised to not make any changes to the system's standard displays.

TEST FORMS AND TOOLS

During the usability test, an instructional set was provided prior to each task but retained by

the administrator. The participants' interaction with RevolutionEHR was monitored digitally with screen share software running on the administrator's machine. A web camera monitored each participant's facial expressions synced with the screen share, and verbal comments were monitored with a microphone. Task timing was achieved with a stopwatch.

PARTICIPANT INSTRUCTIONS

The administrator read the following instructions aloud to each participant prior to testing:

Thank you for participating in this study. Your input is very important. Our session today will last about 60 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. You should complete the tasks as quickly as possible making as few errors as possible. Please try to complete the tasks on your own following the instructions very closely. Please note that we are not testing you we are testing the system, therefore if you have difficulty all this means is 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. Please be honest with your opinions. All 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.

Following the procedural instructions, participants were shown the EHR and as their first task, were given time to explore the system and make comments. Once this task was complete, the administrator gave the following instructions:

For each task, I will read the description to you and say "Begin." At that point, please perform the task and say "Done" once you believe you have successfully completed the task. I would like to request that you not talk aloud or verbalize while you are doing the tasks. I will ask you your impressions about the task once you are done.

Participants were then given 34 tasks to complete. Those tasks are listed in the Results section beginning on page 16.

USABILITY METRICS

According to the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records*, 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:

1. Effectiveness of RevolutionEHR version 7 by measuring participant success rates and errors
2. Efficiency of RevolutionEHR version 7 by measuring the average task time and path deviations
3. Satisfaction with RevolutionEHR version 7 by measuring ease of use ratings

Data Scoring

The following table details how tasks were scored, errors evaluated, and the time data analyzed.

Measures	Rationale and Scoring
<p>Effectiveness: Task Success</p>	<p>A task was counted as a “Success” if the participant was able to achieve the correct outcome without assistance.</p> <p>The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage.</p> <p>Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency.</p>
<p>Effectiveness: Task Failures</p>	<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 a “Failure.” No task times were taken for errors.</p> <p>The total number of errors was calculated for each task and then divided by the total number of times that task was</p>

	<p>attempted. Not all deviations were counted as errors. Instead, only those that were not necessary to arrive at the goal were counted as errors.</p>
Efficiency: Task Deviations	<p>Each participant's path (i.e., steps) through the application was monitored. Deviations occur if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation.</p>
Efficiency: Task Time	<p>Each task was timed from when the administrator said "Begin" until the participant said, "Done." If he or she failed to say "Done," the time was stopped when the participant stopped performing the task. 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. A variance measure (standard deviation) was also calculated.</p>
Satisfaction: Task Rating	<p>Participants' subjective impression of the ease of use of the application was measured by administering both a simple post-task question as well as a post-session survey. After each task, the participant was asked to rate "Overall, this task was:" on a scale of 1 (Very Difficult) to 5 (Very Easy). These data are averaged across participants.</p> <p>Common convention is that average ratings for systems judged easy to use should be 3.3 or above.</p> <p>To measure participants' confidence in and likeability of RevolutionEHR overall, a System Usability Scale (SUS) was obtained post-test via survey. Questions included, "I think I would like to use this system frequently," "I thought the system was easy to use," and "I would imagine that most people would learn to use this system very quickly." See the full System Usability Score survey in Appendix 1.</p>

Results

DATA ANALYSIS AND REPORTING

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above. No participants failed to follow session and task instructions or had their data excluded from the analyses. The usability testing results for RevolutionEHR are detailed in the table below.

Task	N	Task Success	Path Deviation	Task Time		Errors	Task Rating 5 = Easy
	#	Mean (SD)	Deviations (Observed / Optimal)	Mean (SD)	Deviations (Observed / Optimal)	Mean (SD)	Mean (SD)
a1-1: Record medication via CPOE	10	100% (0%)	6.5 / 6	37 sec (8)	37 / 30	0% (0%)	3.7 (1)
a1-2: Change medication via CPOE	10	100% (0%)	4.5 / 4	25 sec (5)	25 / 24	0% (0%)	4.5 (0)
a1-3: Display changed CPOE medication order	10	100% (0%)	3.2 / 3	10 sec (3)	10 / 8	0% (0%)	5.0 (0)
a2-1: Record laboratory test order via CPOE	10	100% (0%)	5.8 / 5	28 sec (3)	28 / 25	0% (0%)	3.5 (1)
a2-2: Change laboratory test order via CPOE	10	100% (0%)	4.0 / 4	24 sec (5)	24 / 24	0% (0%)	4.5 (0)
a2-3: Display changed CPOE laboratory test order	10	100% (0%)	3.1 / 3	9 sec (2)	9 / 8	0% (0%)	5.0 (0)
a3-1: Record diagnostic imaging order via CPOE	10	100% (0%)	5.9 / 5	25 sec (2)	25 / 25	0% (0%)	3.5 (1)
a3-2: Change diagnostic imaging order via CPOE	10	100% (0%)	4.0 / 4	24 sec (5)	24 / 24	0% (0%)	5.0 (0)
a3-3: Display changed CPOE diagnostic imaging test order	10	100% (0%)	3.2 / 3	10 sec (2)	10 / 8	0% (0%)	5.0 (0)
a5-1: Record a patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity	10	100% (0%)	8.2 / 8	15 sec (3)	15 / 15	0% (0%)	4.9 (0)
a5-2: Change the patient's preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity	10	100% (0%)	3.0 / 3	4 sec (4)	4 / 4	0% (0%)	5.0 (0)
a5-3: Display the patient's changed preferred language, date of birth, birth sex, race, ethnicity, sexual orientation, and gender identity	10	100% (0%)	3.1 / 3	9 sec (1)	9 / 8	0% (0%)	5.0 (0)
a6-1: Record a problem to the problem list	10	100% (0%)	1.1 / 1	5 sec (0)	5 / 5	0% (0%)	4.9 (0)
a6-2: Change a problem on the problem list	10	100% (0%)	4.1 / 3	13 sec (1)	13 / 12	0% (0%)	4.3 (1)
a6-3: Display the active problem list	10	100% (0%)	3.3 / 3	11 sec (1)	11 / 10	0% (0%)	5.0 (0)
a6-4: Display the historical problem list	10	100% (0%)	2.0 / 1	5 sec (3)	5 / 3	0% (0%)	4.5 (1)
a7-1: Record a medication to the medication list	10	100% (0%)	1.3 / 1	8 sec (0)	8 / 8	0% (0%)	4.9 (0)



a7-2: Change a medication on the medication list	10	100% (0%)	6.4 / 6	31 Sec (2)	31 / 30	0% (0%)	4.1 (0)
a7-3: Display the active medication list	10	100% (0%)	4.4 / 4	10 sec (1)	10 / 10	0% (0%)	5.0 (0)
a7-4: Display the historical medication list	10	100% (0%)	2.0 / 1	5 sec (3)	5 / 3	0% (0%)	4.5 (1)
a8-1: Record a medication allergy	10	100% (0%)	1.4 / 1	8 sec (1)	8 / 8	0% (0%)	4.9 (0)
a8-2: Change a medication allergy	10	100% (0%)	3.2 / 3	12 sec (0)	12 / 12	0% (0%)	4.1 (0)
a8-3: Display the active medication allergy list	10	100% (0%)	2.1 / 2	10 sec (0)	10 / 10	0% (0%)	5.0 (0)
a8-4: Display the historical medication allergy list	10	100% (0%)	2.0 / 1	5 sec (2)	5 / 3	0% (0%)	4.5 (1)
a9-1: Add a CDS intervention and/or reference resource for each of the required elements	10	80% (42%)	10.0 / 3	30 sec (11)	30 / 15	20% (42%)	3.2 (1)
a9-2: Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements	10	100% (0%)	12.9 / 10	25 sec (10)	25 / 20	0% (0%)	3.0 (1)
a9-3: View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics	10	100% (0%)	2.2 / 2	10 sec (2)	10 / 10	0% (0%)	4.4 (0)
a9-4: Trigger the CDS interventions/resources based on data elements in the problem list, medication list, and medication allergy list by incorporating patient information from a transition of care/referral summary	10	100% (0%)	15 / 10	25 sec (10)	25 / 20	0% (0%)	3.0 (1)
a9-5: Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date	10	100% (0%)	2.5 / 2	9 sec (1)	9 / 9	0% (0%)	4.5 (0)
a14-1: Record UDI	10	90% (32%)	7.5 / 4	223 sec (71)	223 / 120	10% (32%)	2.0 (1)
a14-2: Change UDI Status	10	100% (0%)	3.5 / 3	10 sec (1)	10 / 7	0% (0%)	4.5 (1)
a14-3: Access UDI, device description, identifiers, and attributes	10	100% (0%)	3.1 / 3	10 sec (0)	10 / 10	0% (0%)	4.5 (0)
b2-1: Incorporate a CCDA and conduct reconciliation of the medications, medication allergies, and problems in the CCDA with the information currently in the patient's record	10	100% (0%)	4.6 / 4	32 sec (4)	32 / 30	0% (0%)	3.7 (1)
b2-2: Generate a new CCDA with reconciled data	10	100% (0%)	2.6 / 2	30 sec (6)	30 / 25	0% (0%)	4.4 (1)

The results from the SUS (System Usability Scale – see Appendix 1) scored the subjective satisfaction with the system based on performance with these tasks to be 81.5. Broadly

interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

DISCUSSION OF THE FINDINGS

Based upon the statistical performance during testing and post-test analysis via spreadsheet, it was straightforward to determine areas of success and challenge. Challenges were limited to efficiency rather than failures that could potentially increase the likelihood of adverse consequences.

EFFECTIVENESS

The participants had familiarity with fundamental workflow in RevolutionEHR that resulted in logical connections for newly developed components such as Implantable Devices. Widespread task success was noted without failure.

EFFICIENCY

Significant variability in efficiency was demonstrated particularly in the processes of entry of a unique device identifier for implantable devices and creation of clinical decision support rules. This was to be expected given 1) the participants comfort level with computer use in general, 2) their role within the practice, and, with respect to implantable devices, 3) a new process.

SATISFACTION

Participants expressed satisfaction for usability on all tasks outside of the logging of a unique device identifier for an implantable device and locating and creating clinical decision support rules.

MAJOR FINDINGS

Unique device identifier (UDI) entry and clinical decision support rule creation was time consuming for participants and, in turn, produced errors in task completion.

RISK ANALYSIS

None of the tasks that we classified as “high” or “medium” risk proved to be a challenge for test participants. Each of these tasks were completed successfully with the only variability between them being the time taken to reach completion.

Two “low” risk tasks, a9-1: “Add a CDS intervention and/or reference resource for each of the required elements” and a14-1: “Record UDI”, were the only tasks that produced errors for test participants. Given the high amount of test time required for these tasks, we learned that the associated workflow was confusing and could be enhanced.

We consider these two tasks to be “low” risk because they do not create immediate risk to a patient. Clinical decision support rules are created outside of a patient encounter so any present challenges to rule creation do not impact patient care as it is happening. With respect to the recording of a unique device identifier, this can be done outside of the exam room and could easily be conveyed verbally through case history (and typically would be) prior to recording being completed.

In summary, all but two tasks were completed successfully and those two were classified as “low” risk because they do not pose an immediate risk to the care of a patient.

AREAS FOR IMPROVEMENT

While the challenges associated with manually logging a long-character UDI and creating a clinical decision support rule were noted under a test scenario here, there’s no doubt that these could be intensified within the day-to-day operations of a practice. As such and in line with ISO 9241-210, RevolutionEHR will work toward the addition of barcode scanning abilities to the Implantable Device list for more efficient logging of UDIs and devices as well as improvements in CDS rule creation. Given the input of a cross-section of users representing common eye care employment roles, this usability study will also lead to further enhancements in these areas.

Appendix 1: System Usability Scale (SUS) Survey

Study participants were asked to address each of the following statements with a rating of 1 (Strongly Disagree) to 5 (Strongly Agree).

- 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

SUS yields a single number representing a composite measure of the overall usability of the system being studied. Scores for individual items are not meaningful on their own.

To calculate the SUS score, first sum the score contributions from each item. Each item's score contribution will range from 0 to 4. For items 1,3,5,7, and 9 the score contribution is the scale position minus 1. For items 2,4,6,8 and 10, the contribution is 5 minus the scale position. Multiply the sum of the scores by 2.5 to obtain the overall value of SU. SUS scores have a range of 0 to 100. Participant SUS scores are in the table below.

Participant ID	System Usability Scale Score
ID01	75
ID02	70
ID03	80
ID04	77.5
ID05	97.5
ID06	72.5
ID07	80
ID08	85
ID09	87.5
ID10	90
Average	81.5