

EHR Usability Test Report of Falcon Physician, version TBD

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

Falcon Physician, Version TBD

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EXECUTIVE SUMMARY

A usability test of the Falcon Physician EHR, version TBD, designed for nephrologists, was conducted in March, May, August, and November of 2017 in Denver, CO. The purpose of these tests was to test and validate the usability of the current user interface and provide evidence of usability in the EHR Under Test (EHRUT).

During the usability tests, 31 healthcare providers (30 nephrologists, 1 nurse practitioner) matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

This study collected performance data on 12 overall tasks typically conducted on an EHR:

- Criteria 170.315(a)(1) – CPOE Medications
- Criteria 170.315(a)(2) – CPOE Labs
- Criteria 170.315(a)(3) – CPOE Imaging
- Criteria 170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction
- Criteria 170.315(a)(5) - Demographics
- Criteria 170.315(a)(6) – Problem List
- Criteria 170.315(a)(7) – Medication List
- Criteria 170.315(a)(8) – Medication Allergy List
- Criteria 170.315(a)(9) - Clinical Decision Support
- Criteria 170.315(a)(14) - Implantable Device List
- Criteria 170.315(b)(2) - Clinical Information Reconciliation and Incorporation
- Criteria 170.315(b)(3) - E-Prescribing

During the one-on-one usability test (that ranged from 30-60 mins), each participant was greeted by the administrator and asked to review and sign an informed consent/release form; they were instructed that they could withdraw at any time. All participants had prior experience with the EHR.⁴

The administrator introduced the test and instructed participants to complete a series of tasks (given one at a time) using the EHRUT. 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.

⁴ If training or help materials were provided, describe the nature of it. The recommendation is that all participants be given the opportunity to complete training similar to what a real end user would receive prior to participating in the usability study.

Participant screens, head shots, and audio were recorded for subsequent analysis.

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 – no correspondence could be made from the identity of the participant to the data collected.

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 the EHRUT. See the Falcon SED checklist for a summary of the performance and rating data collected on the EHRUT.

The results from the System Usability Scale (SUS) scored the subjective satisfaction with the system based on performance with these tasks as follows:⁵

Module	SUS
170.315(a)(1) – CPOE Medications	58
170.315(a)(2) – CPOE Labs	58
170.315(a)(3) – CPOE Imaging	58
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction	58
170.315(a)(5) – Demographics	67
170.315(a)(6) – Problem List	58
170.315(a)(7) – Medication List	58
170.315(a)(8) – Medication Allergy List	58
170.315(a)(9) - Clinical Decision Support	76
170.315(a)(14) - Implantable Device List	78
170.315(b)(2) - Clinical Information Reconciliation and Incorporation	71
170.315(b)(3) - E-Prescribing	78

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

MAJOR FINDINGS

Module & Sub Task	Mean Success Rate
170.315(a)(1) – CPOE Medications: Findability	80%
170.315(a)(1) – CPOE Medications: Adding Medication	90%
170.315(a)(1) – CPOE Medications: Diagnosis Code	80%
170.315(a)(2) – CPOE Labs: Findability	40%
170.315(a)(2) – CPOE Labs: New Lab Order Button	30%
170.315(a)(2) – CPOE Labs: Correct Labs	40%
170.315(a)(2) – CPOE Labs: Diagnosis Added	40%
170.315(a)(2) – CPOE Labs: Delete Lab Order	50%
170.315(a)(2) – CPOE Labs: Save & Print	40%
170.315(a)(3) – CPOE Imaging: Findability	20%
170.315(a)(3) – CPOE Imaging: Procedural Code	0%
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Allergy Alert	20%
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Add Medication	90%
170.315(a)(5) – Demographics: Name	64%
170.315(a)(5) – Demographics: SS#	81%
170.315(a)(5) – Demographics: DOB	55%
170.315(a)(5) – Demographics: Gender	81%
170.315(a)(5) – Demographics: Gender Identification	72%
170.315(a)(5) – Demographics: Sexual Orientation	72%
170.315(a)(5) – Demographics: Marital Status	73%
170.315(a)(5) – Demographics: Language	27%
170.315(a)(5) – Demographics: Ethnicity	36%
170.315(a)(5) – Demographics: Race	36%
170.315(a)(6) – Problems List: Findability	100%
170.315(a)(6) – Problems List: Add Problem	100%
170.315(a)(6) – Problems List: Remove Problem	30%
170.315(a)(7) – Medication List: Remove Medication	60%
170.315(a)(7) – Medication List: Refill Medication	40%
170.315(a)(8) – Medication Allergy List: Findability	100%
170.315(a)(8) – Medication Allergy List: Add Allergy	50%
170.315(a)(9) - Clinical Decision Support: Add Encounter	73%
170.315(a)(9) - Clinical Decision Support: Clicks on Alert	0%
170.315(a)(9) - Clinical Decision Support: Can find alerts-Clicks flag	36%
170.315(a)(9) - Clinical Decision Support: Likes/Would use feature	9%
170.315(a)(14) - Implantable Device List: Message Center	70%
170.315(a)(14) - Implantable Device List: Find Ability	67%
170.315(a)(14) - Implantable Device List: Deactivate	91%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks patient's row	82%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation:	100%

Clicks to import clinical info	
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Add meds/etc. to patient list	100%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Allergies & Problems tabs	91%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Save & Close	45%
170.315(b)(3) - E-Prescribing: Pharmacy Change Request	84%
170.315(b)(3) - E-Prescribing: Message Center Contact Pharmacy	75%
170.315(b)(3) - E-Prescribing: Meds Deactivation	97%
170.315(b)(3) - E-Prescribing: Meds Notification	98%

AREAS FOR IMPROVEMENT

Module & Sub Task	Improvement Needed & Suggestion
170.315(a)(1) – CPOE Medications: Findability	Okay
170.315(a)(1) – CPOE Medications: Adding Medication	Functionality okay, but performance is a significant problem within medication field
170.315(a)(1) – CPOE Medications: Diagnosis Code	Diagnosis Code pop-up should be in lightbox or as part of an in-place wizard – significant problem with specific diagnosis selection process
170.315(a)(2) – CPOE Labs: Findability	Problem – most looking for “Orders” term
170.315(a)(2) – CPOE Labs: New Lab Order Button	Highly problematic dual purpose “New” button and confusing actions in drop-down
170.315(a)(2) – CPOE Labs: Correct Labs	Major problem – Very confusing process of locating, searching, and selecting specific labs
170.315(a)(2) – CPOE Labs: Diagnosis Added	Diagnosis Code pop-up should be in lightbox or as part of an in-place wizard – significant problem with specific diagnosis selection process
170.315(a)(2) – CPOE Labs: Delete Lab Order	Participants looking for red “X”; current icon is not clear
170.315(a)(2) – CPOE Labs: Save & Print	Sequential nature of this process doesn’t make sense to participants and is unclear
170.315(a)(3) – CPOE Imaging: Findability	Major Problem – nearly all participants looking for “Orders” or “Radiology” term
170.315(a)(3) – CPOE Imaging: Procedural Code	Multitude of major problems: Not a single participant was able to successfully complete this process—suggest an in-place wizard here (Many other issues within this process)
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Allergy Alert	Problem: very few participants noticed alert
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Add Medication	Adding medication was relatively simple
170.315(a)(5) – Demographics: Name	Needs to improve: conflict with title field (Mr., Ms., etc.)
170.315(a)(5) – Demographics: SS#	Needs to improve: What about patients that only provide last 4 of SS #?
170.315(a)(5) – Demographics: DOB	Needs to improve: Label is problematic (remove “Age” simply provide it to the right of field); don’t

	provide
170.315(a)(5) – Demographics: Gender	Okay
170.315(a)(5) – Demographics: Gender Identification	Okay
170.315(a)(5) – Demographics: Sexual Orientation	Okay
170.315(a)(5) – Demographics: Marital Status	Okay
170.315(a)(5) – Demographics: Language	Needs to improve: Drop-down list of options problematic
170.315(a)(5) – Demographics: Ethnicity	Needs to improve: Drop-down list of options problematic
170.315(a)(5) – Demographics: Race	Needs to improve: Drop-down list of options problematic
170.315(a)(6) – Problems List: Findability	No problem
170.315(a)(6) – Problems List: Add Problem	No problem
170.315(a)(6) – Problems List: Remove Problem	Problematic: 1) participants feared “X” would permanently delete the problem 2) most erroneously clicked the “Inactive” tab instead
170.315(a)(7) – Medication List: Remove Medication	Most successful, but “X” button as delete inconsistently applied
170.315(a)(7) – Medication List: Refill Medication	Major problem: all participants who had no prior experience with this functionality failed; need to rethink the entire process; participants looking for “Refill” button
170.315(a)(8) – Medication Allergy List: Findability	No problem
170.315(a)(8) – Medication Allergy List: Add Allergy	“Drug Class” section (particularly as the default selection) is problematic
170.315(a)(9) - Clinical Decision Support: Add Encounter	No problem
170.315(a)(9) - Clinical Decision Support: Clicks on Alert	Needs to improve: All participants immediately clicked Close
170.315(a)(9) - Clinical Decision Support: Can find alerts-Clicks flag	Needs to improve: If this is deemed important, link to alerts needs to be more clear and prominent
170.315(a)(9) - Clinical Decision Support: Likes/Would use feature	Needs to improve: Nearly all participants find no value in this feature
170.315(a)(14) - Implantable Device List: Message Center	Needs to improve: Participants were not able to find or clearly understand the Clinical Info button— Solved! Validated in subsequent Study: (170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks to import clinical info)
170.315(a)(14) - Implantable Device List: Find Ability	Needs to improve: Nearly all participants couldn’t navigate to implantable devices
170.315(a)(14) - Implantable Device List: Deactivate	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks patient’s row	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks to import clinical info	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Add meds/etc. to patient list	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Allergies & Problems tabs	Most participants didn’t see the Allergies & Problems tabs – Either make more prominent or shift to this section as a 3 part wizard

170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Save & Close	No problem
170.315(b)(3) - E-Prescribing: Pharmacy Change Request	Okay
170.315(b)(3) - E-Prescribing: Message Center Contact Pharmacy	Okay
170.315(b)(3) - E-Prescribing: Meds Deactivation	Okay
170.315(b)(3) - E-Prescribing: Meds Notification	Okay

⁵ See Tullis, T. & Albert, W. (2008). Measuring the User Experience. Burlington, MA: Morgan Kaufman (p. 149). Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

INTRODUCTION

The EHR tested for this study was Falcon EHR, version TBD, which is designed to present medical patient information to healthcare providers in dialysis clinics. The EHRUT provides a data repository for clinic patients and their labs, meds, and medical conditions. The usability testing attempted to represent realistic exercises and conditions.

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 usability ratings and task times, were captured during the usability testing.

METHOD

PARTICIPANTS

A total of 31 participants were tested on the EHRUT(s). Participants in the test were nephrologists and one nurse practitioner.

In addition, participants had no direct connection to the development of or organization producing the EHRUT(s). Participants were not from a 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.

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

32 participants (matching the demographics in the section on Participants) were recruited and 31 participated in the usability test. One participant failed to show for the study.

Participants were scheduled for 30-60 min sessions with at least 30 mins in between each session for debrief by the administrator and to reset systems to proper test conditions. A spreadsheet was used to keep track of the participant schedule.

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 only 1 EHR. Each participant 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 and types 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 Section 3.9 on Usability Metrics.

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:

- a.1 – Enter a patient’s medication information
- a.2 – Order a set of diagnostic labs for a patient
- a.3 – Order a radiology lab for a patient
- a.4 – Enter a patient’s medication when there’s an existing allergy
- a.5 – Enter a patient’s demographic information
- a.6 – Enter a patient’s problem information
- a.7 – Remove a patient’s medication & order a medication refill
- a.8 – Enter a patient’s allergy information
- a.9 – Create a comprehensive encounter and interact with informational alerts
- a.14 – Import and access implantable device information for a patient
- b.2 – Add data from a referral into a patient chart
- b.3 – Interacting with pharmacies regarding patient medications

Tasks were selected based on their frequency of use, criticality of function, and those that may be most troublesome for users.⁶ Tasks should always be constructed in light of the study objectives.

PROCEDURES

Upon arrival, participants were greeted; their identity was verified and matched with a name on the participant schedule. Participants were then assigned a participant ID.⁷ Each participant reviewed and signed an

informed consent and release form. The study administrator witnessed the participant's signature.

The usability administrator conducting the test was an experienced usability practitioner with a master's degree in Human-Centered Design and Engineering and 15 years' experience as a UX Researcher.

The administrator moderated the session including administered the instructions and tasks. The administrator also monitored task times, obtained post-task rating data, and took notes on participant comments. The administrator also served as the data logger and took notes on task success, path deviations, number and type of errors, and comments.

Participants were instructed to perform the tasks (see specific instructions below):

- As quickly as possible making as few errors and deviations as possible.
- Without assistance; administrators were allowed to give immaterial guidance and clarification on tasks, but not instructions on use.

⁶ Constructing appropriate tasks is of critical importance to the validity of a usability test. These are the actual functions, but most tasks contain larger and more fleshed out context that aligns with the sample data sets available in the tested EHR. Please consult usability references for

guidance on how to construct appropriate tasks.
7 All participant data must be de-identified and kept confidential.

For each task, the participants were given instructions on the task. Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated they had completed the task. Scoring is discussed below in Section 3.9.

Following the session, the administrator gave the participant the post-test questionnaire (e.g., the System Usability Scale), compensated them for their time, and thanked each individual for their participation.

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

Participants were thanked for their time and compensated.

TEST LOCATION

The test facility included a recording computer for the administrator. Only the participant and administrator were involved with the test.

To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, and visible to the participants.

TEST ENVIRONMENT

The EHRUT would be typically be used in a healthcare office or facility. In this instance, the testing was conducted in person or remotely. For testing, a laptop was used. The EHR application is web-based.

The participants used mouse and keyboard when interacting with the EHRUT.

TEST FORMS AND TOOLS

During the usability test, various documents and instruments were used, including:

1. Informed Consent
2. Demographic questionnaire
3. Moderator's Guide
4. Post-test Questionnaire

The Moderator's Guide was devised so as to be able to capture the required data.

The participant's interaction with the EHRUT was captured and recorded digitally with screen capture software running on the test machine. A video camera recorded each participant's facial expressions synced with the screen capture and verbal comments were recorded with a microphone.⁸

PARTICIPANT INSTRUCTIONS

The administrator read something similar to 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 60 minutes long. 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. 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.

Once this task was complete, the administrator gave something similar to 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 several tasks to complete.

⁸ There are a variety of tools that record screens and transmit those recordings across a local area network for remote observations.

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 the Falcon EHR by measuring participant success rates and errors
2. Efficiency of the Falcon EHR by measuring the average task time and path deviations
3. Satisfaction with the Falcon EHR by measuring ease of use ratings

DATA SCORING

The following table details how tasks were scored, errors evaluated, and the time data analyzed.¹⁰

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, within the time allotted on a per task basis.</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>Optimal task performance time, as benchmarked by expert performance under realistic conditions, is recorded when constructing tasks. Target task times used for task times in the Moderator’s Guide must be operationally defined by taking multiple measures of optimal performance and multiplying by some factor [e.g., 1.25] that allows some time buffer because the participants are presumably not trained to expert performance. Thus, if expert, optimal performance on a task was [x] seconds then allotted task time performance was [x * 1.25] seconds. This ratio should be aggregated across tasks and reported with mean and variance scores.</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 an “Failures.” 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 attempted. Not all deviations would be counted as errors.¹¹ This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</p>
<p>Efficiency: Task Deviations</p>	<p>The participant’s path (i.e., steps) through the application was recorded. 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>

¹⁰ An excellent resource is Tullis, T. & Albert, W. (2008). Measuring the User Experience. Burlington, MA: Morgan Kaufman. Also see www.measuringusability.com

¹¹ Errors have to be operationally defined by the test team prior to testing.

	It is strongly recommended that task deviations be reported. Optimal paths (i.e., procedural steps) should be recorded when constructing tasks.
Efficiency: Task Time	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. Variance measures (standard deviation and standard error) were also calculated.
Satisfaction: Task Rating	<p>Participant’s 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 questionnaire. 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.¹²</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 the Falcon EHR overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. 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 full System Usability Score questionnaire in Appendix 5.¹³</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.

¹² See Tedesco and Tullis (2006) for a comparison of post-task ratings for usability tests. Tedesco, D. & Tullis, T. (2006) A comparison of methods for eliciting post-task subjective ratings in usability testing. *Usability Professionals association Conference*, June 12 – 16, Broomfield, CO.

¹³ The SUS survey yields a single number that represents a composite measure of the overall perceived usability of the system. SUS scores have a range of 0 to 100 and the score is a relative benchmark that is used against other iterations of the system.

The usability testing results for the EHRUT are detailed in the Falcon SED Checklist¹⁴. The results should be seen in light of the objectives and goals outlined in Section 3.2 Study Design. The data should yield actionable results that, if corrected, yield material, positive impact on user performance.

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be: See SUS chart at end of report. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.¹⁵

¹⁴ Note that this table is an example. You will need to adapt it to report the actual data collected.

¹⁵ See Tullis, T. & Albert, W. (2008). *Measuring the User Experience*. Burlington, MA: Morgan Kaufman (p. 149).

DISCUSSION OF THE FINDINGS

EFFECTIVENESS

Module	Effectiveness
170.315(a)(1) – CPOE Medications	Diagnosis code pop-up is the biggest cause of lack of effectiveness in this task
170.315(a)(2) – CPOE Labs	Lots of challenges with effectiveness, particularly: dual purpose “New” button, problems locating, searching, and selecting specific labs, diagnosis pop-up
170.315(a)(3) – CPOE Imaging	Entering a procedural code is highly problematic
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction	Not noticing alert was biggest problem
170.315(a)(5) – Demographics	Several of the fields and drop-down lists are very problematic and extremely ineffective and unclear
170.315(a)(6) – Problem List	When trying to remove a problem, effectiveness was negatively impacted by confusion over making a medication inactive
170.315(a)(7) – Medication List	Refilling a medication was very ineffective; need to rework task flow and button name
170.315(a)(8) – Medication Allergy List	“Drug Class” and button interaction very confusing and thus ineffective
170.315(a)(9) - Clinical Decision Support	All participants were effective at opening a comprehensive encounter; But all the participants closed the alert box immediately, so the effectiveness of this alert feature is minimal; when forced to review the clinical decision report, most participants found it of little value
170.315(a)(14) - Implantable Device List	Participants were not effective in finding the Clinical Info button or in finding the implantable devices
170.315(b)(2) - Clinical Information Reconciliation and Incorporation	Overall participants were very effective importing clinical data from a referral, encountering only one significant usability issue
170.315(b)(3) - E-Prescribing	Overall participants were the least effective at contacting the pharmacy

EFFICIENCY

Module	Efficiency
170.315(a)(1) – CPOE Medications	Medication field's slow performance decreases efficiency in this task
170.315(a)(2) – CPOE Labs	Not finding "Orders" tab, and performance slowness in displaying lab list problematic
170.315(a)(3) – CPOE Imaging	Nearly no participant being able to find this functionality was a big efficiency problem
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction	This was relatively efficient, despite not noticing allergy alert
170.315(a)(5) – Demographics	Very poor efficiency, overall participants experienced numerous problems entering in basic patient data
170.315(a)(6) – Problem List	Once the confusion over the removal process is clarified for the user, this task would be efficient
170.315(a)(7) – Medication List	Refilling a medication was very inefficient and needs to be reworked
170.315(a)(8) – Medication Allergy List	Sequence of task needs to be streamlined—perhaps in a simple stepped wizard
170.315(a)(9) - Clinical Decision Support	Overall participants were very efficient at adding an encounter; Since all participants closed the alert box immediately, their efficiency wasn't applicable in that case
170.315(a)(14) - Implantable Device List	Message center and the findability of the implantable devices were the most problematic in terms of time and efficiency
170.315(b)(2) - Clinical Information Reconciliation and Incorporation	Overall participants were very efficient importing clinical data from a referral, encountering only one significant usability issue
170.315(b)(3) - E-Prescribing	Contacting the pharmacy proved to be least efficient sub task

SATISFACTION

Module	SUS
170.315(a)(1) – CPOE Medications	58
170.315(a)(2) – CPOE Labs	58
170.315(a)(3) – CPOE Imaging	58
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction	58
170.315(a)(5) – Demographics	67
170.315(a)(6) – Problem List	58
170.315(a)(7) – Medication List	58
170.315(a)(8) – Medication Allergy List	58
170.315(a)(9) - Clinical Decision Support	76
170.315(a)(14) - Implantable Device List	78
170.315(b)(2) - Clinical Information Reconciliation and Incorporation	71
170.315(b)(3) - E-Prescribing	78

MAJOR FINDINGS

Module & Sub Task	Mean Success Rate
170.315(a)(1) – CPOE Medications: Findability	80%
170.315(a)(1) – CPOE Medications: Adding Medication	90%
170.315(a)(1) – CPOE Medications: Diagnosis Code	80%
170.315(a)(2) – CPOE Labs: Findability	40%
170.315(a)(2) – CPOE Labs: New Lab Order Button	30%
170.315(a)(2) – CPOE Labs: Correct Labs	40%
170.315(a)(2) – CPOE Labs: Diagnosis Added	40%
170.315(a)(2) – CPOE Labs: Delete Lab Order	50%
170.315(a)(2) – CPOE Labs: Save & Print	40%
170.315(a)(3) – CPOE Imaging: Findability	20%
170.315(a)(3) – CPOE Imaging: Procedural Code	0%
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Allergy Alert	20%
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Add Medication	90%
170.315(a)(5) – Demographics: Name	64%
170.315(a)(5) – Demographics: SS#	81%
170.315(a)(5) – Demographics: DOB	55%
170.315(a)(5) – Demographics: Gender	81%
170.315(a)(5) – Demographics: Gender Identification	72%
170.315(a)(5) – Demographics: Sexual Orientation	72%
170.315(a)(5) – Demographics: Marital Status	73%
170.315(a)(5) – Demographics: Language	27%
170.315(a)(5) – Demographics: Ethnicity	36%
170.315(a)(5) – Demographics: Race	36%
170.315(a)(6) – Problems List: Findability	100%
170.315(a)(6) – Problems List: Add Problem	100%
170.315(a)(6) – Problems List: Remove Problem	30%
170.315(a)(7) – Medication List: Remove Medication	60%
170.315(a)(7) – Medication List: Refill Medication	40%
170.315(a)(8) – Medication Allergy List: Findability	100%
170.315(a)(8) – Medication Allergy List: Add Allergy	50%
170.315(a)(9) - Clinical Decision Support: Add Encounter	73%
170.315(a)(9) - Clinical Decision Support: Clicks on Alert	0%
170.315(a)(9) - Clinical Decision Support: Can find alerts-Clicks flag	36%
170.315(a)(9) - Clinical Decision Support: Likes/Would use feature	9%
170.315(a)(14) - Implantable Device List: Message Center	70%
170.315(a)(14) - Implantable Device List: Find Ability	67%
170.315(a)(14) - Implantable Device List: Deactivate	91%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks patient's row	82%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks to import clinical info	100%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Add meds/etc. to patient list	100%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Allergies & Problems tabs	91%
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Save & Close	45%

170.315(b)(3) - E-Prescribing: Pharmacy Change Request	84%
170.315(b)(3) - E-Prescribing: Message Center Contact Pharmacy	75%
170.315(b)(3) - E-Prescribing: Meds Deactivation	97%
170.315(b)(3) - E-Prescribing: Meds Notification	98%

AREAS FOR IMPROVEMENT

Module & Sub Task	Improvement Needed & Suggestion
170.315(a)(1) – CPOE Medications: Findability	Okay
170.315(a)(1) – CPOE Medications: Adding Medication	Functionality okay, but performance is a significant problem within medication field
170.315(a)(1) – CPOE Medications: Diagnosis Code	Diagnosis Code pop-up should be in lightbox or as part of an in-place wizard – significant problem with specific diagnosis selection process
170.315(a)(2) – CPOE Labs: Findability	Problem – most looking for “Orders” term
170.315(a)(2) – CPOE Labs: New Lab Order Button	Highly problematic dual purpose “New” button and confusing actions in drop-down
170.315(a)(2) – CPOE Labs: Correct Labs	Major problem – Very confusing process of locating, searching, and selecting specific labs
170.315(a)(2) – CPOE Labs: Diagnosis Added	Diagnosis Code pop-up should be in lightbox or as part of an in-place wizard – significant problem with specific diagnosis selection process
170.315(a)(2) – CPOE Labs: Delete Lab Order	Participants looking for red “X”; current icon is not clear
170.315(a)(2) – CPOE Labs: Save & Print	Sequential nature of this process doesn’t make sense to participants and is unclear
170.315(a)(3) – CPOE Imaging: Findability	Major Problem – nearly all participants looking for “Orders” or “Radiology” term
170.315(a)(3) – CPOE Imaging: Procedural Code	Multitude of major problems: Not a single participant was able to successfully complete this process—suggest an in-place wizard here (Many other issues within this process)
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Allergy Alert	Problem: very few participants noticed alert
170.315(a)(4) – Drug-Drug/Drug-Allergy Interaction: Add Medication	Adding medication was relatively simple
170.315(a)(5) – Demographics: Name	Needs to improve: conflict with title field (Mr., Ms., etc.)
170.315(a)(5) – Demographics: SS#	Needs to improve: What about patients that only provide last 4 of SS #?
170.315(a)(5) – Demographics: DOB	Needs to improve: Label is problematic (remove “Age” simply provide it to the right of field); don’t provide
170.315(a)(5) – Demographics: Gender	Okay
170.315(a)(5) – Demographics: Gender Identification	Okay

170.315(a)(5) – Demographics: Sexual Orientation	Okay
170.315(a)(5) – Demographics: Marital Status	Okay
170.315(a)(5) – Demographics: Language	Needs to improve: Drop-down list of options problematic
170.315(a)(5) – Demographics: Ethnicity	Needs to improve: Drop-down list of options problematic
170.315(a)(5) – Demographics: Race	Needs to improve: Drop-down list of options problematic
170.315(a)(6) – Problems List: Findability	No problem
170.315(a)(6) – Problems List: Add Problem	No problem
170.315(a)(6) – Problems List: Remove Problem	Problematic: 1) participants feared “X” would permanently delete the problem 2) most erroneously clicked the “Inactive” tab instead
170.315(a)(7) – Medication List: Remove Medication	Most successful, but “X” button as delete inconsistently applied
170.315(a)(7) – Medication List: Refill Medication	Major problem: all participants who had no prior experience with this functionality failed; need to rethink the entire process; participants looking for “Refill” button
170.315(a)(8) – Medication Allergy List: Findability	No problem
170.315(a)(8) – Medication Allergy List: Add Allergy	“Drug Class” section (particularly as the default selection) is problematic
170.315(a)(9) - Clinical Decision Support: Add Encounter	No problem
170.315(a)(9) - Clinical Decision Support: Clicks on Alert	Needs to improve: All participants immediately clicked Close
170.315(a)(9) - Clinical Decision Support: Can find alerts-Clicks flag	Needs to improve: If this is deemed important, link to alerts needs to be more clear and prominent
170.315(a)(9) - Clinical Decision Support: Likes/Would use feature	Needs to improve: Nearly all participants find no value in this feature
170.315(a)(14) - Implantable Device List: Message Center	Needs to improve: Participants were not able to find or clearly understand the Clinical Info button— Solved! Validated in subsequent Study: (170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks to import clinical info)
170.315(a)(14) - Implantable Device List: Find Ability	Needs to improve: Nearly all participants couldn’t navigate to implantable devices
170.315(a)(14) - Implantable Device List: Deactivate	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks patient’s row	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks to import clinical info	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Add meds/etc. to patient list	No problem
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Allergies & Problems tabs	Most participants didn’t see the Allergies & Problems tabs – Either make more prominent or shift to this section as a 3 part wizard
170.315(b)(2) - Clinical Information Reconciliation and Incorporation: Clicks Save & Close	No problem
170.315(b)(3) - E-Prescribing: Pharmacy Change Request	Okay

170.315(b)(3) - E-Prescribing: Message Center Contact Pharmacy	Okay
170.315(b)(3) - E-Prescribing: Meds Deactivation	Okay
170.315(b)(3) - E-Prescribing: Meds Notification	Okay