EHR Usability Test Report of Bayview EMR 2.1

Report based on NISTIR 7742 Customized Common Industry Format Template for Electronic Health Record Usability Testing

Bayview EMR 2.1

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Report Prepared By: Jeffrey Elmore, Director of Information Systems, Bayview Physicians Group
757-686-3500
cehrt@bayviewphysicians.com
3241 Western Branch Blvd, Chesapeake, VA 23321

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EXECUTIVE SUMMARY

A usability test of Bayview EMR 2.1 was conducted on 12/26/2018 and 12/27/2018 in the office of North Suffolk Family Medicine, 3235 Bridge Road, Suffolk, VA 23435 by Bayview Physicians Group. The purpose of this test was to test and validate the usability of the current user interface, and provide evidence of usability in the Bayview EMR, the EHR Under Test (EHRUT). During the usability test, six healthcare providers and clinical staff matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

This study collected performance data on four task areas typically conducted on an EHR:

- CPOE Lab Orders
- CPOE Radiology Orders
- Problem List
- Clinical Decision Support

During the 15 minute one-on-one usability test, each participant was greeted by the administrator and asked to review and sign an informed consent/release form (included in Appendix 3); they were 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 the EHRUT. During the testing, the administrator timed the test and, along with the data logger, recorded user performance data on paper. 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 – no correspondence could be made from the identity of the participant to the data collected. Following the conclusion of the testing, participants were asked to complete a post-test questionnaire. 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. Following is a summary of the performance and rating data collected on the Bayview EMR.

Measure / Task	N	Task Success	Path Deviation	Task Time		Errors	Task Ratings
	#	Mean % (SD)	Deviations (Observed / Optimal)	Mean (SD) Seconds	Deviations (Observed / Optimal)	Mean % (SD)	Mean (SD) (5=Easy)
Record Lab order via CPOE	10	100%	1.09	55 (28)	1.10	0%	4.6 (0.66)
Change Lab order via CPOE	10	100%	1.07	20 (9)	1.09	0%	5.0
Display changed CPOE Lab order	10	100%	1.00	7 (3)	1.18	0%	5.0
Record Imaging order via CPOE	10	100%	1.12	56 (28)	1.13	0%	4.6 (0.49)
Change Imaging order via CPOE	10	100%	1.03	19 (7)	1.04	0%	5.0
Display changed CPOE Imaging order	10	100%	1.00	7 (2)	1.20	0%	5.0
Record a problem to the problem list	10	100%	1.00	20 (13)	1.25	0%	5.0
Change a problem on the problem list	10	90% (30%)	1.06	16 (11)	1.34	20% (40%)	4.9 (0.31)
Display the active problem list	10	100%	1.03	11 (7)	1.57	0%	5.0
Display the historical problem list	10	100%	1.00	6 (2)	0.90	0%	5.0
Add a CDS intervention and/or reference resource for each of the required elements	10	100%	1.10	24 (15)	1.20	0%	4.8 (0.40)
Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements	10	97.2% (5.6%)	1.00	99 (30)	1.24	30% (64%)	4.8 (0.28)
View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics	10	100%	1.00	46 (13)	1.20	0%	5.0
Trigger the CDS interventions/resources based on data elements in the problem list, medication list, and medication allergy list by incorporating patient	10	100%	1.00	106 (13)	1.17	0%	5.0

information from a transition of care							
Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date	10	90% (30%)	1.00	8 (2)	1.10	10% (30%)	5.0

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be: **98.27**%

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

- Major findings

CPOE Lab and Radiology Orders: All participants found it relatively easy to create, update and view CPOE lab orders and CPOE radiology orders. Most participants accessed the CPOE orders feature from the Interoperability Dashboard. A few users accessed the CPOE orders feature using PowerTab buttons. While both access methods are appropriate, the PowerTabs access option is more cumbersome and adds time to the overall task. Several users commented that order creation screen would be even easier to complete if there was a search or filter text box that could be used to more quickly locate the lab or radiology item to order. Participants stated that the list of tests was lengthy, which made it harder for the participant to locate the test to be ordered. Additionally, physician and nurse practitioner users indicated that the CPOE order creation feature would benefit from allowing users to "repeat" orders for a patient for orders that require repetitive and scheduled orders, such as CMP, BMP, and Lipid Panels that are needed every six months. Finally, some users that were less familiar took longer to complete the tasks due to initial unfamiliarity with the feature.

Problem List: Participants have had several years of experience using the problem list feature. All users commented that the problem list addition feature was easy to use. No user had difficulty adding a problem to the problem list. They valued the integration of the problem search feature on the problem list addition screen. Two users commented that sometimes it is time consuming to find the correct problem when searching for a problem that has a lot of search results returned. As an example, one user stated that searching for "pregnancy", the results list almost one hundred possible matches that contain the word pregnancy, but don't start with the word. It was suggested by the user that there be an option to search for "contains" or "starts with" to help constrain the large amount of results returned. No participants had difficulty changing a problem to inactive, or viewing active and historical problems. In general, users commented that the problem list feature, as a whole, was stable and well tested.

Clinical Decision Support: Participants were impressed with the ease of use of the clinical decision support (CDS) interactions. All users felt that the CDS functionality of the EMR was very easy to use. They felt that the interventions were medically relevant and were helpful to the clinicians. Most participants commented verbally on the ease of access to the diagnostic and therapeutic information of the InfoButton linked to the CDS intervention. Users felt that the InfoButton feature will greatly reduce the amount of time that it takes a clinician to access relevant clinical information. One user suggested that newly added CDS interventions are not easily recognizable as they "blend in" with other CDS interventions that were already activated for the patient.

- Areas for improvement

CPOE: The order entry user interface lacks a search feature to help users find test items to order. While this does not hinder the user from ordering the test, it can introduce an undesired delay in the ordering

process while the user searches the alphabetical list of possible tests. This area of improvement was identified during previous UCD and testing sessions.

CPOE: When a provider would like to order a repeat of a test that has already been ordered for the patient, the provider must create the order from scratch. This can increase the amount of time it takes to order tests that are ordered frequently. Adding a "repeat" order feature would greatly reduce the amount of time it takes to order repeating orders.

Problem List: The problem search feature lacks the ability to narrow the results returned. When searching for some problem names, a large amount of results may get returned, making it difficult and more time consuming to find the desired problem. Adding a "starts with" and "contains" feature could potentially reduce the number of results returned. This may not be a complete solution, but would be a step in the right direction to improving the search results feature of the problem list. We will continue to engage other users to obtain feedback on how to improve this functionality.

Clinical Decision Support: CDS interventions are listed in a comma-separated list format. They are all of the same font and color. It can be difficult to see newly activated interventions because they blend in together. One user suggested that we should change the color of newly activated CDS interventions as they are added to the patient chart. Perhaps we should also change the display format to a bulleted list instead of comma separated.

General: While not an incorrect workflow, some user efficiency was affected by users now knowing of newer, more efficient methods to access CPOE order creation screens. Users were still accessing CPOE order creation screens using older methods that are slower than the new methods. Additional training notices and documentation updates should be created to notify users that more efficient methods are available to access the CPOE order creation areas.

INTRODUCTION

The EHRUT tested for this study was Bayview EMR 2.1. It is designed to present medical information to healthcare providers in an outpatient ambulatory environment. The Bayview EMR consists of various modules and interfaces design to capture, display, and modify patient clinical data. 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 time on task, user satisfaction, and deviation from optimal paths, were captured during the usability testing.

METHOD

Bayview EMR Design Process

The Bayview EMR design process follows the same principles of human-centered design and fits in to our overall quality management system (QMS). The system involves users in the overall design and software development process. The design team includes individuals with skills spanning across multiple disciplines and with different perspectives. The team works to address the entire user experience through a deep understanding of the tasks and workflows required by end users. The process is iterative and requirements are continually updated to better address the context of use, increase usability, and reduce user error.

Bayview EMR is developed using the user-design processes and guidelines based on NISTR7741, and others published by the U.S. Dept. of Health and Human Services. The Research-Based Web Design & Usability Guidelines, Enlarged/Expanded edition. Washington: U.S. Government Printing Office, 2006.

The main steps of the process are:

- Understanding/stating the context of use for the function or module
    - Business requirements are gathered from internal and client stakeholders. These stake holders are kept up to date with product developments through regular meetings.
- Creating design solutions
    - A design team consisting of developers, quality leaders, and business analysts work to design several possible solutions and through further analysis with stakeholders the solution is refined.
- Creating user requirements
    - Business analysis creates full requirements documents based on feedback from the design team.
- Evaluating the solution
    - Solution prototypes are created and vetted against the original understanding of the context of use.
- Performing user centered evaluations
    - Formal summative user testing is performed and the analysis is sent back to the design team. The results are then used to drive future iterations of the product.

The following tasks and modules were developed based on the Bayview EMR design process:

§ 170.315(a)(2) (CPOE Laboratory)

§ 170.315(a)(3) (CPOE Diagnostic Imaging)

§ 170.315(a)(6) (Problem list)

§ 170.315(a)(9) (Clinical decision support)

INTENDED USERS

The Bayview EMR 2.1 software is intended to be used by users in all job functions of the outpatient healthcare setting with levels of experience. Examples of intended users include, but are not limited to, patient care advocates, medical receptionists, medical assistants, nurses, physician assistants, nurse practitioners, physicians, clinic managers, and administrators.

PARTICIPANTS

The testing methods were in accordance with the Bayview EMR Design Process. A total of ten participants were tested on the EHRUT(s). Participants in the study included physicians, nurse practitioners, nurses, medical assistants, and patient care advocates from the family medicine specialty. 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; an example of a screener is provided in Appendix 1.

Most participants were very familiar with the functionality of the features of the system under test. There were two participants that had less familiarity with the Clinical Decision Support areas. There were two

other participants that had less familiarity with the CPOE areas. These users had some difficulty in completing portions of the respective tasks where they were less familiar.

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 randomly generated from the demographics collection tool so that an individual's data cannot be tied back to individual identities.

ID	Gender	Age	Occupation/Role	Medical Experience (Months)	EHR Experience (Months)	Computer Experience (Months)
1	Female	30-39	Practice Administrator	204	84	264
2	Female	50-59	MA	324	60	240
3	Male	50-59	MA (Paramedic)	372	36	336
4	Female	50-59	Practice Administrator	48	48	360
5	Female	50-59	Physician	354	108	240
6	Female	50-59	Nurse Practitioner	384	5	360
7	Female	30-39	Physician	48	5	252
8	Female	20-29	Patient Care Advocate	24	9	240
9	Female	20-29	Patient Care Advocate	240	120	240
10	Female	30-39	Nurse (RN)	72	72	240
11	Female	20-29	Nurse (RN)	84	200	60
12	Female	50-59	Patient Care Advocate	300	280	76

Twelve participants (matching the demographics in the section on Participants) were recruited and ten participated in the usability test. One recruit was not present on the testing dates. One other participant declined to participate on the testing dates.

Participants were scheduled for 15 minute sessions with 5 minutes in between each session for debrief by the administrator and data logger, and to reset systems to proper test conditions. A spreadsheet was used to keep track of the participants, and included each participant's demographic characteristics.

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 one EHR. Each participant used the same computer system in the same room, 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 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:

1. CPOE - Labs:
   a. Record Lab order via CPOE
   b. Change Lab order via CPOE
   c. Display changed CPOE Lab order
2. CPOE – Diagnostic Imaging:
   a. Record Imaging order via CPOE
   b. Change Imaging order via CPOE
   c. Display changed CPOE Imaging order
3. Problem List:
   a. Record a problem to the problem list
   b. Change a problem on the problem list
   c. Display the active problem list
   d. Display the historical problem list
4. Clinical Decision Support:
   a. Add a CDS intervention and/or reference resource for each of the required elements
   b. Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements
   c. View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics
   d. 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
   e. Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date

Tasks were selected based on their frequency of use, criticality of function, and those that may be most troublesome for users.

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. Each participant reviewed and signed an informed consent and release form (See Appendix 3). A representative from the test team witnessed the participant's signature.

To ensure that the test ran smoothly, the administrator participated in the test.

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. The test 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
• Without assistance; administrators were allowed to give immaterial guidance and clarification on tasks, but not instructions on use.
• Without using a think aloud technique.

For each task, the participants were given a written copy of the task. 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 below in Section 3.9.

Following the session, the administrator gave the participant the post-test questionnaire (the System Usability Scale, see Appendix 5) 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.

TEST LOCATION

The tests were performed in a testing area where the EHRUT would typically be deployed and used in production. Only the participant and the administrator were in the testing area. 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 on a computer where interactions with the EHRUT would typically take place in real world office scenarios. For testing, the computer used a Windows PC running windows 7 with a standard mouse and keyboard.

The Bayview EMR 2.1 system was viewed on a 19-inch vertical monitor in portrait mode. The application was set up by the Bayview Physicians Group according to standard operating procedures for client/server installation. The application itself was running on a Windows 2016 Server using a Training SQL database on a WAN connection. Technically, the system performance (i.e., response time) was representative to what actual users would experience in a field implementation. Additionally, participants were instructed not to change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

During the usability test, various documents and instruments were used, including:
1. Informed Consent and Non-Compete Agreement

2. Moderator and Tasks Guide
3. Post-test Questionnaire

Examples of these documents can be found in Appendices 3-5 respectively. The Moderator and Tasks Guide was devised to be able to capture required data.

PARTICIPANT INSTRUCTIONS

The administrator reads the following instructions aloud to the each participant:

Thank you for participating in this study. Our session today will last about 15 minutes. During that time you will take a look at an early prototype of Bayview EMR 2.1.

I will ask you to complete a few tasks using this system and answer some questions. 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. You will be asked to complete these tasks on your own trying to do them as quickly as possible with the fewest possible errors or deviations. Please do not do anything more than asked. If you get lost or have difficulty I cannot help you with anything to do with the system.

Please save your detailed comments until the end of a task or the end of the session as a whole when we can discuss freely. Since this is a test system some of the data may not make sense as it is placeholder data. We are recording the screen of our session today for our internal use only.

Do you have any questions or concerns?

Following the procedural instructions, participants were shown the EHR. 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 21 tasks to complete. Tasks are listed in the tasks guide in Appendix 4.

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 Bayview EMR 2.1 by measuring participant success rates and errors
2. Efficiency of Bayview EMR 2.1 by measuring the average task time and path deviations
3. Satisfaction with Bayview EMR 2.1 by measuring ease of use ratings

DATA SCORING

The following table (Table 1) details how tasks were scored, errors evaluated, and the time data analyzed

Measures	Rationale and Scoring
Effectiveness:	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.
Task Success	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. Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency and was recorded. 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 were defined by taking multiple measures of optimal performance and multiplying each time by a factor of 1.5. This factor allows some time buffer, as participants are presumably not trained to expert performance. Thus, if expert performance on a task was [x] seconds then optimal task time performance was [x * 1.5] seconds. The ratio of reported time to optimal time was aggregated across tasks and reported with mean.
Effectiveness: Task Failures	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 "Failures." No task times were taken for errors. On a qualitative level, an enumeration of errors and error types was collected and is described in the narrative section below.
Efficiency: Task Deviations	The participant's path through the application was recorded. Deviations occur if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, opened an incorrect module, 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. Optimal paths were recorded in the moderator guide. Task deviations are discussed further in the qualitative sections.
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.
Satisfaction: Task Rating:	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 Easy) to 5 (Very Difficult). These data are averaged across participants. Common convention is that average ratings for systems judged easy to use should be 3.3 or below. To measure participants' confidence in and likeability of the Bayview EMR 2.1 overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. Questions included, "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.

Table 1. Details of how observed data were scored.

RESULTS

DATA ANALYSIS AND REPORTING

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above. Participants who failed to follow session and task instructions had their data excluded from the analyses.

There were a few minor issues which may have affected data collection. The task descriptions and the terminology used could have contributed to some hesitation on the part of the user when completing tasks. Efforts were made to use descriptions and terminology which would be familiar to users; however, some users still may have experienced some confusion.

The usability testing results for the EHRUT are detailed below (see Table 2).

Measure / Task	N	Task Success	Path Deviation	Task Time		Errors	Task Ratings
	#	Mean % (SD)	Deviations (Observed / Optimal)	Mean (SD) Seconds	Deviations (Observed / Optimal)	Mean % (SD)	Mean (SD) (5=Easy)
Record Lab order via CPOE	10	100%	1.09	55 (28)	1.10	0%	4.6 (0.66)
Change Lab order via CPOE	10	100%	1.07	20 (9)	1.09	0%	5.0
Display changed CPOE Lab order	10	100%	1.00	7 (3)	1.18	0%	5.0
Record Imaging order via CPOE	10	100%	1.12	56 (28)	1.13	0%	4.6 (0.49)
Change Imaging order via CPOE	10	100%	1.03	19 (7)	1.04	0%	5.0
Display changed CPOE Imaging order	10	100%	1.00	7 (2)	1.20	0%	5.0
Record a problem to the problem list	10	100%	1.00	20 (13)	1.25	0%	5.0
Change a problem on the problem list	10	90% (30%)	1.06	16 (11)	1.34	20% (40%)	4.9 (0.31)
Display the active problem list	10	100%	1.03	11 (7)	1.57	0%	5.0
Display the historical problem list	10	100%	1.00	6 (2)	0.90	0%	5.0
Add a CDS intervention and/or reference resource for each of the required elements	10	100%	1.10	24 (15)	1.20	0%	4.8 (0.40)
Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements	10	97.2% (5.6%)	1.00	99 (30)	1.24	30% (64%)	4.8 (0.28)
View the intervention/resource	10	100%	1.00	46	1.20	0%	5.0

				(13)			
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	10	100%	1.00	106 (13)	1.17	0%	5.0
Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date	10	90% (30%)	1.00	8 (2)	1.10	10% (30%)	5.0

Table 2.Usability Testing Results

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be: 98.27. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.[1]

DISCUSSION OF THE FINDINGS

EFFECTIVENESS

Based on the findings, most users were quite effective at using the EHRUT. The average number of failures per task was 0.04. Errors were primarily due to the user selecting an incorrect action that made the test fail, or by taking paths outside of the scope of the test.

Some users spent additional time making sure that they had typed information correctly, which contributed to higher time to perform the task. However, making certain that data is entered correctly contributes to an overall patient safety goal of this project.

Most test participants were quite effective and showed very few, if any path deviations. This finding could be partially attributed to the testing circumstances. Specifically, most participants were very familiar with the functionality of the features of the system under test. There were two participants that had less familiarity with the Clinical Decision Support areas. There were two other participants that had less familiarity with the CPOE areas. These users had some difficulty in completing portions of the respective tasks where they were less familiar.

Risk Prone Errors

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

When discussing errors, it is important to note which tasks are more likely to result in errors and what types of errors are most likely to cause patient safety issues. Tasks which do not alter the patient's record but simply display information to the user are less likely to lead to errors. Viewing order details and reviewing the patient's prescription history does not involve the user entering or alerting data, so the chance of error is very low. The system will only allow an order to be generated when all medically necessary information has been entered, so there is no chance of an incomplete order being sent to the lab

Tasks which require the user to enter data are more prone to error. To that end every effort should be made to ensure that the user can clearly discern what has been selected on the screen and that they are given an opportunity to double check and "cancel" actions before they are committed.

Below is a prioritized list of tasks in the order of the associated risk and with a rating of the risk (1-3, where 1 is a low risk and 3 is a high risk)

Task	Risk Level
Record a problem to the problem list	3
Record Imaging order via CPOE	3
Record Lab order via CPOE	3
Add a CDS intervention and/or reference resource for each of the required elements	2
Change a problem on the problem list	2
Change Imaging order via CPOE	2
Change Lab order via CPOE	2
Access the following attributes for one of the triggered CDS interventions/resources: bibliographic citation, developer, funding source, release/revision date	1
Display changed CPOE Imaging order	1
Display changed CPOE Lab order	1
Display the active problem list	1
Display the historical problem list	1
Trigger the CDS interventions/resources added using the applicable data elements from each of the required elements	1
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	1
View the intervention/resource information using the Infobutton standard for data elements in the problem list, medication list, and demographics	1

EFFICIENCY

The average deviations ratios (observed path / optimal path) in the group tested were close to 1.0 for all tasks. Even users who were unable to complete a task in a timely were on the correct path and rarely deviated into a different area of the software. We attribute higher time deviations to participants that were thorough in their tests, carefully selecting diagnoses and CPOE orders. Thus, we conclude that users were relatively efficient when completing the tasks set before them.

We did identify that some users were unaware of more efficient ways to access the CPOE order creation features, thus increasing the amount of time that it took the user to navigate to the CPOE order creation screen.

SATISFACTION

The results from the SUS (System Usability Scale) (appendix 5) scored the subjective satisfaction with the system based on performance with these tasks to be **90.8**, an improvement of 3.6 satisfaction points above the last survey performed. Verbal feedback, as well as task ratings, concludes that there is a high level of comfort and overall satisfaction with the system. Specifically, users stated that the system is "easy to use", "simple and intuitive," "user friendly," and "organized logically." These statements, along with other participant verbalizations, suggest a high level of usability within the system.

There are of course some areas of improvement, which are discussed below, but even so the average task ease of use rating was between 1.0 and 2.0 for each task. As set forth in the data scoring section, average ratings for systems judged easy to use should be 3.3 or below. Hence, a major finding of this testing was that the modules tested are very easy to use.

MAJOR FINDINGS

CPOE Lab and Radiology Orders: All participants found it relatively easy to create, update and view CPOE lab orders and CPOE radiology orders. Most participants accessed the CPOE orders feature from the Interoperability Dashboard. A few users accessed the CPOE orders feature using PowerTab buttons. While both access methods are appropriate, the PowerTabs access option is more cumbersome and adds time to the overall task. Several users commented that order creation screen would be even easier to complete if there was a search or filter text box that could be used to more quickly locate the lab or radiology item to order. Participants stated that the list of tests was lengthy, which made it harder for the participant to locate the test to be ordered. Additionally, physician and nurse practitioner users indicated that the CPOE order creation feature would benefit from allowing users to "repeat" orders for a patient for orders that require repetitive and scheduled orders, such as CMP, BMP, and Lipid Panels that are needed every six months. Finally, some users that were less familiar took longer to complete the tasks due to initial unfamiliarity with the feature.

Problem List: Participants have had several years of experience using the problem list feature. All users commented that the problem list addition feature was easy to use. No user had difficulty adding a problem to the problem list. They valued the integration of the problem search feature on the problem list addition screen. Two users commented that sometimes it is time consuming to find the correct problem when searching for a problem that has a lot of search results returned. As an example, one user stated that searching for "pregnancy", the results list almost one hundred possible matches that contain the word pregnancy, but don't start with the word. It was suggested by the user that there be an option to search for "contains" or "starts with" to help constrain the large amount of results returned. No participants had difficulty changing a problem to inactive, or viewing active and historical problems. In general, users commented that the problem list feature, as a whole, was stable and well tested.

Clinical Decision Support: Participants were impressed with the ease of use of the clinical decision support (CDS) interactions. All users felt that the CDS functionality of the EMR was very easy to use. They felt that the interventions were medically relevant and were helpful to the clinicians. Most participants commented verbally on the ease of access to the diagnostic and therapeutic information of the InfoButton linked to the CDS intervention. Users felt that the InfoButton feature will greatly reduce the amount of time that it takes a clinician to access relevant clinical information. One user suggested that newly added CDS interventions are not easily recognizable as they "blend in" with other CDS interventions that were already activated for the patient.

AREAS FOR IMPROVEMENT

CPOE: The order entry user interface lacks a search feature to help users find test items to order. While this does not hinder the user from ordering the test, it can introduce an undesired delay in the ordering process while the user searches the alphabetical list of possible tests. This area of improvement was identified during previous UCD and testing sessions.

CPOE: When a provider would like to order a repeat of a test that has already been ordered for the patient, the provider must create the order from scratch. This can increase the amount of time it takes to order tests that are ordered frequently. Adding a "repeat" order feature would greatly reduce the amount of time it takes to order repeating orders.

Problem List: The problem search feature lacks the ability to narrow the results returned. When searching for some problem names, a large amount of results may get returned, making it difficult and more time consuming to find the desired problem. Adding a "starts with" and "contains" feature could potentially reduce the number of results returned. This may not be a complete solution, but would be a step in the right direction to improving the search results feature of the problem list. We will continue to engage other users to obtain feedback on how to improve this functionality.

Clinical Decision Support: CDS interventions are listed in a comma-separated list format. They are all of the same font and color. It can be difficult to see newly activated interventions because they blend in together. One user suggested that we should change the color of newly activated CDS interventions as they are added to the patient chart. Perhaps we should also change the display format to a bulleted list instead of comma separated.

General: While not an incorrect workflow, some user efficiency was affected by users now knowing of newer, more efficient methods to access CPOE order creation screens. Users were still accessing CPOE order creation screens using older methods that are slower than the new methods. Additional training notices and documentation updates should be created to notify users that more efficient methods are available to access the CPOE order creation areas.

APPENDICES

The following appendices include supplemental data for this usability test report. Following is a list of the appendices provided:

1: Sample Recruiting Screener
2: Participant Demographics
3: Non-Disclosure Agreement (NDA) and Informed Consent Form
4: Moderator's Guide
5: System Usability Scale Questionnaire

Appendix 1: SAMPLE RECRUITING SCREENER

The purpose of a screener to ensure that the participants selected represent the target user population as closely as possible. Rather than reaching out to individual participants, Bayview Physicians Group opted to target the Practice Administrator and rely upon them to select qualified participants based on the functionality being tested.

Recruiting Scripts:

Hello, my name is _____, and I am calling from Bayview Physicians Group. We are recruiting participants for a usability study on the Bayview EMR. Would you be willing to participate, along with staff members? This is strictly for research purposes. We will primarily be conducting tests on the usability of the new clinical decision support and computerized physician order entry. Could you identify users in the practice such as physicians, medical assistants, and technicians who use this module? Once you have identified those users, please send them a demographics questionnaire.

Would you be able to participate on December 26th? The test will take place at your office.

Thank you and we appreciate your time.

Appendix 2: PARTICIPANT DEMOGRAPHICS

Following is a high-level overview of the participants in this study.

Total Participants   **12**

Gender		**Occupation/Role**	
Men	1	Physician/NP	3
Women	11	Nurse/MA	4
		Technician	0
Age		Manager	2
20-29	3	Other	3
30-39	3		
40-49	0	**Years of Experience**	
50-59	6	0-2	2
60+	0	3-5	2
		6-9	1
Race/Ethnicity		10+	7
Caucasian	9		
Asian	0		
Black/African-American	3		
Latino/a or Hispanic	0		
Other	0		

Following is a full participant breakdown:

ID	Sex	Age	Education	Role	Professional Experience	Computer Experience	Product Experience	Assistive Technology Needs
ID 01	Female	30-39	Associate Degree	Practice Administrator	204	264	84	No
ID 02	Female	50-59	Trade/technical/vocational training	MA	324	240	60	No
ID 03	Male	50-59	Trade/technical/vocational training	MA (Paramedic)	372	336	36	No
ID 04	Female	50-59	Bachelor's Degree	Practice Administrator	48	360	48	No
ID	Female	50-	Doctorate degree (e.g., MD, DNP,	Physician	354	240	108	No

ID	Gender	Age	Education	Role				
05	le	59	DMD, PhD)					
ID 06	Female	50-59	Master's Degree	Nurse Practitioner	384	360	5	No
ID 07	Female	30-39	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	48	252	5	No
ID 08	Female	20-29	Bachelor's Degree	Patient Care Advocate	24	240	9	No
ID 09	Female	20-29	High school graduate, diploma or the equivalent (for example: GED)	Patient Care Advocate	240	240	120	No
ID 10	Female	30-39	Bachelor's Degree	Nurse (RN)	72	240	72	No
ID 11	Female	20-29	Bachelor's Degree	Nurse (RN)	84	200	60	No
ID 12	Female	50-59	Some college credit, no degree	Patient Care Advocate	300	280	76	No

Appendix 3: NON-DISCLOSURE AGREEMENT AND INFORMED CONSENT FORM

Non-Disclosure Agreement

THIS AGREEMENT is entered into as of *December 26, 2018*, between

_____ ("the Participant") and the testing organization *Bayview Physicians Group* located at *3241 Western Branch Blvd, Chesapeake, VA 23321*.
.
The Participant acknowledges his or her voluntary participation in today's usability study may bring the Participant into possession of Confidential Information. The term "Confidential Information" means all technical and commercial information of a proprietary or confidential nature which is disclosed by *Bayview Physicians Group*, or otherwise acquired by the Participant, in the course of today's study.

By way of illustration, but not limitation, Confidential Information includes trade secrets, processes, formulae, data, know-how, products, designs, drawings, computer aided design files and other computer files, computer software, ideas, improvements, inventions, training methods and materials, marketing techniques, plans, strategies, budgets, financial information, or forecasts.

Any information the Participant acquires relating to this product during this study is confidential and proprietary to *Bayview Physicians Group* and is being disclosed solely for the purposes of the Participant's participation in today's usability study. By signing this form the Participant acknowledges that s/he will not disclose this confidential information obtained today to anyone else or any other organizations.

Participant's printed name: _____

Signature: _____

Date: _____

Informed Consent

Bayview Physicians Group 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 *30* minutes.

Agreement
I understand and agree that as a voluntary participant in the present study conducted by *Bayview Physicians Group* 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 *Bayview Physicians Group.*

I understand and consent to the use and release of the recording by *Bayview Physicians Group*. I understand that the information and recording is for research purposes only and that my name and image will not be used for any purpose other than research. I relinquish any rights to the recording and understand the recording may be copied and used by *Bayview Physicians Group* without further permission.

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 with outside of *Bayview Physicians Group and Bayview Physicians Group's* client. 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:
X - YES, I have read the above statement and agree to be a participant.
☐ NO, I choose not to participate in this study.

Signature: _____

Date: _____

BAYVIEW EMR Usability Test

Moderator's Guide

Administrator _____
Data Logger _____
Date _____ Time _____
Participant # _____
Location _____

Prior to testing
☐ Confirm schedule with Participants
☐ Ensure EHRUT lab environment is running properly
☐ Ensure lab and data recording equipment is running properly

Prior to each participant:
☐ Reset application
☐ Start session recordings with LogMeIn Rescue
Prior to each task:
☐ Reset application to starting point for next task

After each participant:
☐ End session recordings with LogMeIn Rescue

After all testing
☐ Back up all data files

Orientation

Thank you for participating in this study. Our session today will last about 20 minutes. During that time you will take a look at an early prototype of Bayview EMR 2.1.

I will ask you to complete a few tasks using this system and answer some questions. 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.

You will be asked to complete these tasks on your own trying to do them as quickly as possible with the fewest possible errors or deviations. Please do not do anything more than asked. If you get lost or have difficulty I cannot answer help you with anything to do with the system itself.

Please save your detailed comments until the end of a task or the end of the session as a whole when we can discuss freely. Since this is a test system some of the data may not make sense as it is placeholder data. We are recording the screen of our session today for our internal use only.

Do you have any questions or concerns?

Participant ID:

Task 1: Record Lab Order via CPOE

Please use the Orders app to create a Laboratory order for Total Cholesterol with facility Any Lab Site, a date, and a priority of stat for patient Alice Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 50 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for a patient (ex. Brown, Paul)
3) User clicks on the "Add Lab Order" hyperlink on the orders menu
4) User selects diagnosis
5) User searches for and selects Total Cholesterol
6) User enters facility
7) User enters due date
8) User enters priority
9) User enters a reason for order
10) User selects Create Order

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 2: <u>Change</u> Lab Order via CPOE (Cancel)

Please use the Orders app to cancel a Laboratory order of Total Cholesterol for patient Alice Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 18 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for a patient (ex. Brown, Paul)
3) User clicks on the Lab Orders power tab
4) User selects the order to update
5) User selects Edit, then updated the reason for order
6) User selects Save and returns to the Lab Orders list

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 3: Display Changed CPOE Lab Order

Please use the Orders module to access patient Alice Testpatient's laboratory orders.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 6 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for a patient (ex. Brown, Paul)
3) User clicks on the Lab Orders power tab
4) User views the orders module for the selected laboratory order
5) User confirms that the reason for order has been changed

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 4: <u>Record</u> Imaging Order via CPOE

Please use the Orders app to create an Imaging order for a knee x-ray of both knees with facility Any Radiology Site, a date, and a priority of stat for patient Cameron Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 50 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for a patient (ex. Brown, Paul)
3) User clicks on the "Add Radiology Order" hyperlink on the order menu
4) User selects diagnosis
5) User searches for and selects MRI Knee
6) User enters facility
7) User enters due date
8) User enters priority
9) User enters a reason for order
10) User selects Create Order

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 5: Change Imaging Order via CPOE (Cancel)

Please use the Orders app to cancel a Radiology order of MRI Abdomen for patient Cameron Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 18 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for a patient (ex. Brown, Paul)
3) User clicks on the Radiology Orders
4) User selects the order to update
5) User selects Edit, then updated the reason for order
6) User selects Save and returns to the Radiology Orders list

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 6: Display Changed CPOE Imaging Order

Please use the Orders module to access patient Cameron Testpatient's radiology orders.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 6 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for a patient (ex. Brown, Paul)
3) User clicks on the Radiology Orders power tab
4) User views the orders module for the selected radiology order
5) User confirms that the reason for order has been changed

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 7: Record a Problem to the Problem List

Please add a new problem to the problem list for patient Alice Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 16 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User selects "Add Problem" from the Problems menu
3) User searches for and selects a problem
4) User selects "Chronic" and "Active" option
5) User enters a problem date
6) User leaves the notes section empty
7) User clicks Save and closes the window

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 8: <u>Change</u> a Problem on the Problem List

Please change an active problem to inactive an inactive status for patient Abby Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 12 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User clicks on an existing active problem in the Problem List section
3) User changes the problem to Inactive
4) User clicks the save button and closes the window

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 9: Display the Active Problem List

Please display the active problem list for patient Cameron Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 7 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User clicks on Active hyperlink at the top of the Problem List section
3) User observes all active problems are displayed

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 10: <u>Display</u> the Historical Problem List

Please display the historical problem list for patient Alice Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 7 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User clicks on the All hyperlink at the top of the Problem List section
3) User observes all problems, including inactive and resolved, are displayed

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 11: View clinical decision support rule based on Rx allergy data

Please use the Rx module to add view the interactions alert for penicillin for patient Abby Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 20 seconds

Optimal Path
1) User has Clinical Decision Support interventions activated
2) User is on the Desktop Interoperability Dashboard
3) User searches for a Patient listed above
4) User notes that the patient is allergic to "Amoxicillin"
5) User opens Rx
6) User selects an intolerant drug (**penicillin**)
7) User checks for and observes an interaction alert for selected drug

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 12: View clinical decision support rule based on patient demographics data.

Please search for patient Cameron Testpatient and view any clinical decision support rules on the Interoperability dashboard

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 10 seconds

Optimal Path
1) User is on the Desktop Clinical Summary
2) User searches for patient listed above
3) User views age-based clinical decision support rules based on the current patient's demographics

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 13: View clinical decision support rule based on vitals data

Please find patient Alice Testpatient and use the vitals app to add a blood pressure of 145/80 to the patient's chart for today's date. View the clinical decision support rule on the Interoperability dashboard

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 10 seconds

Optimal Path

1) User has Clinical Decision Support interventions activated
2) User is on the Desktop Interoperability Dashboard
3) User searches for a Patient (ex. Certain age, certain number of encounters)
4) User opens Vitals application
5) User adds new Vitals to Patient (ex. Blood Pressure, weight, ABI)
6) User views Desktop Interoperability Dashboard
7) User sees Clinical Decision Support Alert appear on Interoperability Dashboard

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 14: View clinical decision support rule based on medication list data

Please find patient Cameron Testpatient. View the medication-based clinical decision support rule on the Interoperability dashboard.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 10 seconds

Optimal Path
1) User has Clinical Decision Support interventions activated
2) User is on the Desktop Interoperability Dashboard
3) User searches for a Patient (ex. Certain age, certain number of encounters)
4) User views Desktop Interoperability Dashboard
5) User sees medication-based Clinical Decision Support Alert appear on Interoperability Dashboard. The alert will indicate that the patient should be taking a statin.

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 15: View clinical decision support rule based on problem list data

Please find patient Alice Testpatient. View the problems-based clinical decision support rule on the Interoperability dashboard.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 10 seconds

Optimal Path
1) User has Clinical Decision Support interventions activated
2) User is on the Desktop Interoperability Dashboard
3) User searches for a Patient (ex. Certain age, certain number of encounters)
4) User views Desktop Interoperability Dashboard
5) User sees problems-based Clinical Decision Support Alert appear on Interoperability Dashboard. The alert will indicate that the patient should be taking aspirin based on age and a problem of diabetes.

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 16: View clinical decision support rule based on lab results data

Please find patient Abby Testpatient. View the lab results-based clinical decision support rule on the Interoperability dashboard.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 10 seconds

Optimal Path
1) User has Clinical Decision Support interventions activated
2) User is on the Desktop Interoperability Dashboard
3) User searches for a Patient (ex. Certain age, certain number of encounters)
4) User views Desktop Interoperability Dashboard
5) User sees lab results-based Clinical Decision Support Alert appear on Interoperability Dashboard. The alert will indicate that the patient should receive an A1C blood test based on not having an A1C lab test on file and a problem of diabetes.

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 17: View clinical decision support rule based on a combination of data

Please find patient Cameron Testpatient. View a CDS intervention that is based on more than one of the following data elements: problem list, medication list, medication allergy, demographics, lab results, or vital signs.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 10 seconds

Optimal Path
1) User has Clinical Decision Support interventions activated
2) User is on the Desktop Interoperability Dashboard
3) User searches for a Patient (ex. Certain age, certain number of encounters)
4) User views Desktop Interoperability Dashboard
5) User sees a CDS alert for Statin, which is based on the patient's problem list and medication list.

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 18: View diagnostic and therapeutic reference information

Please use the clinical decision support app to view the diagnostic and therapeutic reference information for an active clinical decision support rule for patient Cameron Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 40 seconds

Optimal Path
1) User has Clinical Decision Support Interventions activated
2) User searches for a Patient
3) User views Interoperability Dashboard
4) User clicks on a CDS alert based on problem list data
5) User clicks on information button on the clinical decision support alert details window to view diagnosis to view diagnostic and therapeutic reference information
6) User clicks on a CDS alert based on medication list data
7) User clicks on information button on the clinical decision support alert details window to view diagnosis to view diagnostic and therapeutic reference information
8) User clicks on a CDS alert based on demographics data
9) User clicks on information button on the clinical decision support alert details window to view diagnosis to view diagnostic and therapeutic reference information

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 19: View bibliographic citation, developer, funding source, release/revision date information

Please use the clinical decision support app to view the bibliographic citation, developer, funding source, release/revision date information for an active clinical decision support rule for patient Cameron Testpatient.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 7 seconds

Optimal Path
1) User has Clinical Decision Support Interventions activated
2) User searches for a Patient
3) User views Interoperability Dashboard
4) User clicks on a CDS alert
5) User notes the bibliographic citation, developer, funding source, release/revision date information listed on the CDS alert details

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 20: Clinical Decision Support Rule Configuration

Please use the clinical decision support admin powertab to assign clinical decision support rules to users

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 20 seconds

Optimal Path
1) User searches for a Patient
2) User selects the CDS admin powetab
3) User selects their username from the list of users
4) User selects and adds a CDS rule for each of the following:
   a. 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 above
5) User selects save

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)

Administrator / Notetaker Comments:

Task 21: Trigger CDS alerts based on data elements in the problem list, medication list, and medication allergy list by incorporating patient information from a transfer of care/referral summary

Please import problem list, medication list, and medication allergy data from a transfer of care/referral summary, then confirm that the CDS rules applicable to those areas are triggered.

Success:
☐ Easily completed
☐ Completed with difficulty or help :: Describe below
☐ Not completed

Comments:
Task Time: _____ Seconds   Optimal Time: 90 seconds

Optimal Path
1) User searches for patient
2) User notes that the CDS alerts for the following are already triggered:
    a. Aspirin
    b. Statin
3) User selects the "Reconcile External Data" menu item.
4) User selects the following items to add to the chart:
    a. Problem List – Depression
    b. Medication List – Aspirin
    c. Medication Allergy - Statin
5) User returns to dashboard and notes that the CDS alert for Aspirin is no longer triggered because the patient is on Aspirin, that the CDS alert for Statin is no longer triggered because the patient is allergic to Statins, and that a new CDS alert appears for PHQ-9 since the patient has a new diagnosis of Depression.

☐ Correct
☐ Minor Deviations / Cycles :: Describe below
☐ Major Deviations :: Describe below

Comments:

Observed Errors and Verbalizations:

Comments:

Rating:

Overall, this task was: _____
Show participant written scale: "Very Easy" (1) to "Very Difficult" (5)
Administrator / Notetaker Comments:

Appendix 5: SYSTEM USABILITY SCALE QUESTIONNAIRE

This questionnaire was adapted from John Brooke's "SUS: a "quick and dirty" usability scale" at Digital Equipment Corporation in the UK.[2] Participants completed this questionnaire on paper after the test.

System Usability Scale

Strongly Disagree   Strongly Agree

1. I think that I would like to use this system frequently

   1   2   3   4   5

2. I found the system unnecessarily complex

   1   2   3   4   5

3. I thought the system was easy to use

   1   2   3   4   5

4. I think that I would need the support of a technical person to be able to use this system

   1   2   3   4   5

5. I found the various functions in this system were well integrated

   1   2   3   4   5

6. I thought there was too much inconsistency in this system

   1   2   3   4   5

7. I would imagine that most people would learn to use this system very quickly

   1   2   3   4   5

8. I found the system very cumbersome to use

   1   2   3   4   5

9. I felt very confident using the system

   1   2   3   4   5

10. I needed to learn a lot of things before I could get going with this system

   1   2   3   4   5

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[2] Brooke, J. (1996). "SUS: a "quick and dirty" usability scale." In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & A. L. McClelland. *Usability Evaluation in Industry*. London: Taylor and Francis.