

170.315(g)(3) Safety-Enhanced Design Usability Test Report of Millennium CD (Clinical)

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

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Report Prepared By: Rebecca Green, Ph.D
Lead Human Factors Researcher
Cerner Corporation
2800 Rockcreek Parkway
Kansas City, MO 64117
816-446-1484
rebecca.green@cerner.com

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EXECUTIVE SUMMARY

A usability test of Cerner's Millennium CD (Clinical) was conducted remotely May 15 through Jun. 5, 2019 by Cerner. The purpose of this test 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 test, 13 healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

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

- Add, Remove and Edit the Problem List
- Add, Remove and Edit Physician Orders, and if relevant, route them to the patient's preferred pharmacy
- Review and respond to Drug-Allergy and Drug-Drug Interaction Checking notifications

During the 60-minute one-on-one usability test, each participant was greeted by the administrator and asked to review and provided a recorded verbal agreement to an informed consent/release form; 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 recorded user performance data electronically. The administrator did not give the participant assistance in how to complete the task unless required for task workflow. Participant screens 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. 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 EHRUT.

Task Description	n	Task Success % (SD)	Path Deviations (Obs./Optimal)	Mean Optimal Task Time in sec. (SD)	Mean Deviation Task Time (Obs./Optimal)	Errors (SD)	Task Ratings (SD)
UT1. (a)(6) Problem List	13	85 (15)	21/65	62.86 (47.19)	63/76	0.32 (0.77)	4.8 (1.8)
UT3. (a)(1) CPOE – Meds, (a)(4) IxC	13	100 (0)	24/195	339.54 (132.84)	340/323	0.12 (1.14)	3.5 (1.8)
UT5. (a)(2) CPOE – Labs	13	92 (8)	11/104	165.46 (98.73)	165/114	0.11 (1.21)	4.2 (2.2)
UT6. (a)(3) CPOE – Img.	13	92 (8)	7/104	160.68 (97.09)	161/61	0.07 (0.97)	4.8 (1.5)
UT9. (b)(3) ePrescribe	10	70 (30)	5/20	81.6 (113.65)	82/89	0.28 (0.53)	3.4 (2.2)
UT10. (a)(6) Problem List	13	77 (23)	7/130	172.5 (126.26)	172/97	0.05 (0.78)	4.2 (2.3)
UT11. (a)(7), (b)(3) ePrescribe	11	100 (0)	3/33	96.88 (93.63)	97/26	0.09 (0.90)	4.2 (1.3)
UT12. (a)(1) CPOE – Meds	12	67 (33)	12/192	238.54 (203.75)	239/261	0.07 (0.83)	4.3 (1.0)
UT13. (a)(4) IxC	10	80 (20)	22/144	184.47 (111.81)	184/117	0.14 (4.89)	5.6 (1.4)
UT14. (b)(3) ePrescribe	10	80 (20)	6/27	67.95 (49.44)	68/13	0.20 (1.26)	49.0 (21.5)

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be: 49 for all clinicians.

In addition to the performance data, the following observations and recommendations based on those findings were made:

- Most of the deviations and task failures were related to a baseline level of lostness while working through tasks with new functional capabilities or due to various technical system issues including but not limited to: diagnosis association and the inability to complete a cancel/DC. These technical system issues contributed to difficulty using the system which resulted in overall lower task ratings.

- The highest impact problem identified was in relation to Workflow 170.315(a)(1) CPOE – Medications. The task failures seen for this task were due to inability to accurately indicate a medication regimen/schedule. The medication orders were presented in the order catalog, the details were pre-defined, yet due to the number of options provided clinicians were not able to pick out the correction orderable.

INTRODUCTION

The purpose of this document is to report on summative testing performed by Cerner Corporation to evaluate the usability of its Millennium CD (Clinical) electronic health record (EHR) software within the intended use of the product for specified workflows. To evaluate and provide evidence of the usability of this system, the effectiveness, efficiency and user satisfaction were measured by collecting success rates, error and deviation rates, time on task and user satisfaction ratings as reported in this document. The areas of improvement provide detailed information about the test results and recommendations for resolving problems. All testing artifacts used to perform the usability evaluations are included in the appendices.

METHOD

Participants

Recruited participants had a mix of backgrounds and demographic characteristics conforming to the solution and role tested. The following is a table of participants by characteristics, including demographics, professional experience, computing experience. Participant names were replaced with Participant IDs so that an individual's data cannot be tied back to individual identities in this report. The use of corrective lenses were not included in reporting the use of assistive technology.

A total of 13 participants were tested on Millennium CD (Clinical) software over the course of three weeks for 1 hour sessions. Participants in the test were clinical staff representing physician and nursing roles.

See Table 1 for the detailed participant information.

Table 1. All Participants Demographics.

	ID #	Role	Specialty	Education	Gender	Age Range	Professional Experience (Yrs.)	EHR/ Product Experience (Yrs.)	Computer Experience (Yrs.)	Computer Proficiency *	Assistive Tech. Needs
1	3021	MD	General Surgery	Professional degree (MD, DO, DMD)	M	40 to 49	1	5	7	5	No
2	3338	MD	Endocrinology	Professional degree (MD, DO, DMD)	M	60 to 69	26	5	16	3	No
3	3329	MD	Family Medicine/ Emergency Medicine	Professional degree (MD, DO, DMD)	M	30 to 39	5	0	9	4	No
4	3328	MD	Hospitalist /Family Medicine	Professional degree (MD, DO, DMD)	M	40 to 49	15	0	15	4	No
5	3327	MD	Cardiology	Professional degree (MD, DO, DMD)	M	40 to 49	20	.5	12	5	No
6	2217	MD	Family Medicine	Professional degree (MD, DO, DMD)	M	30 to 39	9	5	13	5	No
7	66	MD	Pediatrics	Professional degree (MD, DO, DMD)	M	30 to 39	8	10	9	3	No

8	2792	MD	Internal	Professional degree (MD, DO, DMD)	F	50 to 59	21	0	15	5	No
9	3330	MD	Internal	Professional degree (MD, DO, DMD)	M	40 to 49	11	5	15	4	No
10	3343	MD	Internal Medicine	Professional degree (MD, DO, DMD)	F	60 to 69	29	0	13	5	No
11	1520	MD	Family Medicine	Professional degree (MD, DO, DMD)	M	30 to 39	7	10	9	5	No
12	1186	MD	Family Medicine	Professional degree (MD, DO, DMD)	F	30 to 39	7	0	7	3	No

*Computer proficiency is a self-reported rating of comfort with computers, where 5 – very comfortable.

Study Design

The objective of this test was to gather information about Cerner Millennium CD (Clinical) usability within the product's intended use in acute care or inpatient settings. For the purpose of this report, usability is defined as the efficiency, effectiveness and satisfaction of participants utilizing the system to complete specific task workflows. The results of this test will be used to provide Cerner product management staff with data to drive future requirements.

Tasks and the supporting data setup were designed by Cerner in-house clinicians to simulate clinical practice and to cover the required safety-enhanced design workflows. These materials were then reviewed by a physician from a client site to further ensure their verisimilitude.

Artificiality factors were inadvertently inserted as a result of the data setup and these caused some challenges for the test participants. Examples of the data setup factors include poor or unrealistic organization of picklists; poor spelling or capitalization in the naming of items to be ordered. Additionally, as the environment was shared, data setup was complicated by conflicting configuration requirements so that the testing team encountered unexpected system behaviors at every site.

Tasks

Test tasks were designed to be realistic examples of the tasks a clinician would perform in an acute care setting. A clinical scenario was designed by Cerner in-house clinicians to provide the context or background for both sets of tasks. The tasks themselves were written to cover both the safety-enhanced design workflows required for system certification by the Office of the National Coordinator for Health Information Technology and additional safety features available within Millennium CD (Clinical). The complete set of tasks and research questions covered in this usability test are included in Appendices A and B of this document.

Procedures

Test participants were scheduled for 60-minute test sessions and arrived as individual participants. Each participant was assigned a number to identify results while detaching the identity of the individual from the responses and observations. A moderator conducted each test and introduced the purpose of the testing and its procedures and instructions verbally. Participants completed an online demographic data collection form during the recruiting process as part of determining eligibility for the sessions.

Each participant was provided with a clinical scenario providing the background context for the task workflows. Each participant was given the chance to read the scenario and ask any questions, then began to perform the tasks required to achieve the desired outcome. Each session was recorded with the Morae software. The facilitator took notes on the participant's interaction with the system. Tasks were timed primarily via Morae, starting from the point when the participant clicked the "Start Task" button and ending when the participant clicked "End Task". In a few cases when participating physicians were obliged to interrupt a task in order to respond to patient care questions, timings were re-taken by stopwatch from the recording. After each task, the participant was asked to answer one subjective question related to the ease of completing the task.

Upon completing all of the tasks, the participant was asked to respond to standard System Usability Scale (SUS) questions. Finally, they were encouraged to respond to open-ended questions and describe any likes or dislikes in regards to the system and their interactions with it.

System Tested

The usability testing that was performed is representative of the state of the UI design as it existed at the time of the usability testing performed on May 15 through June 5, 2019.

Test Location and Environment

Remote desktop testing was conducted on a remote desktop using a screen sharing application. The participants used a mobile device when interacting with the EHR. The test application itself was running on a public server using a test database on a LAN/WAN connection. The application was set up according to the solution documentation describing the minimum hardware, software and network configurations. The participant's interaction with the EHR was captured and recorded digitally with screen capture software running on the test machine.

Usability Metrics

The system was evaluated for effectiveness, efficiency and satisfaction as defined by measures collected and analyzed for each participant.

The goals of the test were to assess:

1. Effectiveness by measuring participant success rates and errors.
2. Efficiency by measuring the participants' task time and path deviations.

3. Satisfaction by measuring ease of use ratings.

Test Forms and Tools

During the testing, the following forms and tools were used to present and collect data:

- The Demographics questionnaire collected as part of the recruiting process (See Appendix A)
- Morae Recorder was used to record each test session, time the tasks, and collect data from the subjective surveys. The online survey included System Usability Scale questionnaire. Data collected in Morae was later downloaded to an Excel spreadsheet for analysis and reporting.
- General Instructions to participant (See Appendix B)
- Scenario, Task instructions and Task Rating (See Appendix C)

Participant Instructions

Appendix B provides the script used by the test moderator when explaining the test procedures and the purpose of the usability testing.

Within the testing sessions when encountering an unfamiliar task workflow (e.g., one not typically used at the participant's facility), participants were instructed to try their best to figure it out. Only if they indicated verbally that they were stuck or needed help were participants prompted as to the use of the system. This provided useful insights on the intuitiveness and learnability of the user interface.

USABILITY SCORING

The quantitative information collected consisted of measurable results that we analyzed to determine how the test participants performed compared to established benchmarks. Some of the quantitative information we collected included time spent on task, the percentage of test participants succeeding or failing at tasks, and so on. The following table (Table 2) details how tasks were scored, errors evaluated, and the time data analyzed.

Table 2. Details of How Observed Data were scored.

Measure	Scoring
Effectiveness: Task Success	<p>A task was counted as “Passed” if the participant was able to achieve the correct outcome, without assistance. If the participant abandoned the task, did not reach the correct answer or performed it incorrectly the task was counted as “Failed”.</p> <p>The total number of successes were calculated for each task and then divided by the total number of participants that attempted. Successful tasks were evaluated on a threshold of 80% as successful.</p> <p>On a qualitative level, an enumeration of errors and error types were collected.</p>
Effectiveness: Deviation Rate	<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 identified for the task or solution tested.</p> <p>The deviation rate was calculated as the total number of errors over the total chance for errors across all participants based on the optimal path.</p>
Efficiency: Task Time	<p>Each task was timed from when the participant selected a “Start Task” button until the participant selected an “End Task” button. The task times were then recorded as part of the session recording based on the participant’s selection of the Start and End task button. Only task times for tasks that were successfully completed were included in the average task time analysis.</p> <p>The average time on task for all participants was used as the baseline.</p>
Satisfaction: System Usability Scale (SUS)	<p>Participant’s subjective impression of the ease of use of the application was measured by administering a standardized post-task questionnaire.</p>

	Scores under 60 represent systems with poor usability; scores over 80 would be considered above average.
Satisfaction: Single Ease of Use Question	At the end of each task, the participant was presented with the Single Ease of Use survey question. Using a Likert scale (with 1 as very difficult and 7 as very easy), they were asked to rate the difficulty of the task.

Some of the information collected was qualitative, consisting of subjective impressions and opinions about the solution. Some of the qualitative data collected included: facial expressions, verbal comments when participants “thought out loud”, spontaneous verbal expressions (comments), and miscellaneous activities performed by the participant during the test session. While much of the qualitative commentary was collected during testing, qualitative feedback was also gathered in the questionnaires and post-test interviews.

To prioritize area(s) of improvement, a categorization of problem severity classification will be used in the analysis of the data collected during evaluation activities. The approach treats problem severity as a combination of three factors: the frequency of users experiencing the problem during the evaluation (likelihood of occurrence), the probability of detecting a problem based on the total number of participants’ evaluated (likelihood of detection), and the likelihood that harm would occur (severity). The combination of these three factors can be used to identify a Risk Priority Number (RPN).

Critical – RPN values representing high impact problems that prevent a user from correctly completing one or more product functions and may be of serious risk to patient safety.

High – RPN values representing moderate to high impact problems that often prevent a user from correctly completing one or more product functions and may be frequent, persistent, or affect many users.

Medium – RPN values representing moderate frequency problems with low to moderate impact that causes users moderate confusion or irritation.

Low – RPN values representing low frequency problems with low impact that cause users mild confusion or irritation. These may include minor inconsistencies that cause hesitation or small aesthetic issues.

RESULTS

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above. The data should yield actionable results that, if corrected, produce a material, positive impact on user performance. The quantitative and qualitative summary of responses is indicated for each task below.

Workflow 170.315 (a)(1) CPOE Medications

Participating physicians were assigned three tasks (see tasks UT3 and UT12) in which they ordered medications or revised existing medication orders.

Table 3. Task-based results for CPOE Medications tasks.

	UT3	UT12
Task Success Rate	100%	67%
Task Failure Rate	0%	33%
Deviation Rate	12%	7%
Mean Time on Task	339.5s	238.5s
Average User Rating	3.5	4.3

Usability Results for Task

The most common error identified for task UT3 was related to users attempting to proceed with incomplete order detail information. This error is already mitigated through design in the form of an alert that prevents a user from signing orders with incomplete required information.

The most common error identified for task UT12 was related to physicians not completing required fields in the medication order details. Most physicians were observed selecting incomplete or empty orderables even when completed orderables were provided at the top of the pick list when the search is performed. Choosing the empty orderable requires additional steps and the potential for additional errors.

Usability Findings for Task

No recommendations – no usability issues discovered. Organization of the quick order lists depend on configuration by the client to ensure they are well organized for the type of care and medical specialties within the facility.

Workflow 170.315 (a)(2) CPOE Labs

Participating physicians were asked to order a lab test(s) for diagnostic purposes related to the reason for visit as represented in the clinical scenario (see task UT5). Physicians were provided recommended lab tests only upon request to the facilitator and could include any of the following: Troponin I/T, Creatinine Kinase – Total and MB, and/or Electrocardiogram (EKG).

Table 4. Task-based results for CPOE Laboratory tasks.

	UT5
Task Success Rate	92%
Task Failure Rate	8%
Deviation Rate	11%
Mean Time on Task	165.5s
Average User Rating	4.2

Usability Results for Task

The most common error identified for task UT5 was around potential delays in care by not including a STAT priority for the lab order. Alternatively, one physician was observed selecting a Point of Care orderable for the lab which may be representative of organizational policies and not related to the inherent usability of the system. The participant failure occurred because the participant did not see a required field in the details, and could not complete the Diagnoses field. The participant recognized that details were missing, but could not figure out how to remedy.

Usability Findings for Task

No recommendations – no usability issues discovered. Organization of the quick order lists depend on configuration by the client to ensure they are well organized for the type of care and medical specialties within the facility.

Workflow 170.315 (a)(3) CPOE Imaging

Participating physicians were asked to order two different imaging studies (see task UT6): chest x-ray and transthoracic echocardiogram (TTE).

Table 5. Task-based results for CPOE Imaging tasks.

	UT6
Task Success Rate	92%
Task Failure Rate	8%
Deviation Rate	7%

Mean Time on Task	160.7s
Average User Rating	4.8

Usability Results for Task

The most common error identified for task UT6 was related to finding the correct order for the TTE from the search options. Additional errors were associated with completing the order details before signing the order and selecting the blank orderables instead of the built orderable.

Usability Findings for Task

No recommendations – no usability issues discovered. Organization of the order lists depend on configuration by the client to ensure they are well organized for the type of care and medical specialties within the facility.

Workflow 170.315 (a)(4) Drug-Drug & Drug-Allergy Interaction Checking

Participating physicians were assigned two different reconciliation tasks in which they ordered medications or revised existing medication orders. In these tasks, one or more of the orders generated an alert for drug to drug interaction (see UT3.1 and UT13).

Table 6. Task-based results for Drug-Drug & Drug-Allergy Interaction Checking tasks.

	UT3.1	UT13
Task Success Rate	100%	80%
Task Failure Rate	0%	20%
Deviation Rate	12%	14%
Mean Time on Task	339.5s	184.5s
Average User Rating	3.5	5.6

Usability Results for Task

The most common error identified for task UT3.1 was related to understanding the content within the Drug-Drug interaction window. The most common error identified for task UT13 was related to physicians overriding unexpected interactions.

Usability Findings for Task

1. **Medium Priority:** Participants found the content in the Drug-Drug/Drug-Allergy interaction window difficult to use to make clinical decisions. Consider alternative designs for the layout and content of the interaction window. [\[TABLE 12. Finding ID 2.\]](#)

Workflow 170.315 (a)(6) Problem List

Participating physicians were asked to both update an existing problem as resolved (see task UT1) and to add two new problems (see task UT10).

Table 7. Task-based results for Problem List tasks.

	UT1	UT10
Task Success Rate	85%	77%
Task Failure Rate	15%	23%
Deviation Rate	32%	5%
Mean Time on Task	62.9s	172.5s
Average User Rating	4.8	4.2

Usability Results for Task

The most common error identified for task UT1 was related to physicians attempting to indicate a resolved problem by ‘unselecting’ the chronic modifier instead of selecting the ‘resolved’ option. While most of the participating physicians were able to complete the task of updating an existing problem’s status, many of them did not follow the optimal path to do so.

The most common error identified for task UT10 was for physicians to select the simplest form of anemia and not include the information that it was due to blood loss. However, two physicians were observed adding the ‘due to blood loss’ as part of the problem comments.

Usability Findings for Task

2. **Low Priority:** Consideration should be given to redesigning the Cerner Millennium CD (Clinical) Problems to incorporate distinct steps for type of condition versus status of the condition. [[TABLE 12. Finding ID 1.](#)]

Workflow 170.315 (a)(7) Medication List

Participating physicians were asked to review the patient’s home medications list and identify medications needing refills (see task UT11).

Table 8. Task-based results for Medicaiton List tasks.

	UT11
Task Success Rate	100%
Task Failure Rate	0%
Deviation Rate	9%
Mean Time on Task	96.9
Average User Rating	4.2

Usability Results for Task

The most common error identified for task UT11 was related to physicians misunderstanding the visual indication of the refill counter. However, all physicians were able to successfully identify which medications needed attention from a clinical treatment perspective.

Usability Findings for Task

No recommendations – no usability issues discovered.

Workflow 170.315 (b)(3) Electronic Prescribing

Participating physicians were asked to review prescription information (see UT11.1) and ensure that any new prescriptions would be sent to the patient’s preferred pharmacy (see UT9 and UT14).

Table 9. Task-based results for Electronic Prescribing tasks.

	UT9	UT11.1	UT14
Task Success Rate	70%	100%	80%
Task Failure Rate	30%	0%	20%
Deviation Rate	28%	9%	20%
Mean Time on Task	81.6s	96.9s	67.95s
Average User Rating	3.4	4.2	--

Usability Results for Task

The most common error identified for task UT11.1 was related to physicians being confused by a mismatch in the visual indicator showing red fill but with a value of 0 labelling the visualization. Most physicians identified the medication with a value of 0 for the refills.

The most common error identified for tasks UT9 and UT14 was related to completing order details based on validation error notification. All of the physicians recognized that they would “need to put in the prescription to send to the pharmacy...” while placing the order. In fact, most of the physicians demonstrated where and how they would do further validation or change the preferred pharmacy if needed.

Usability Findings for Task

No recommendations – no usability issues discovered. Physicians recognized and followed the safety design mitigation embedded in electronic prescribing associated with controlled substances.

Summary of Measures by Task

Table 10. Effectiveness, Efficiency, and Satisfaction Scores for Millennium CD (Clinical).

Task Description	n	Task Success % (SD)	Path Deviations (Obs./Optimal)	Mean Optimal Task Time in sec. (SD)	Mean Deviation Task Time (Obs./Optimal)	Errors (SD)	Task Ratings (SD)
UT1. (a)(6) Problem List	13	85 (15)	21/65	62.86 (47.19)	63/76	0.32 (0.77)	4.8 (1.8)
UT3. (a)(1) CPOE – Meds, (a)(4) IxC	13	100 (0)	24/195	339.54 (132.84)	340/323	0.12 (1.14)	3.5 (1.8)
UT5. (a)(2) CPOE – Labs	13	92 (8)	11/104	165.46 (98.73)	165/114	0.11 (1.21)	4.2 (2.2)
UT6. (a)(3) CPOE – Img.	13	92 (8)	7/104	160.68 (97.09)	161/61	0.07 (0.97)	4.8 (1.5)
UT9. (b)(3) ePrescribe	10	70 (30)	5/20	81.6 (113.65)	82/89	0.28 (0.53)	3.4 (2.2)
UT10. (a)(6) Problem List	13	77 (23)	7/130	172.5 (126.26)	172/97	0.05 (0.78)	4.2 (2.3)
UT11. (a)(7), (b)(3) ePrescribe	11	100 (0)	3/33	96.88 (93.63)	97/26	0.09 (0.90)	4.2 (1.3)
UT12. (a)(1) CPOE – Meds	12	67 (33)	12/192	238.54 (203.75)	239/261	0.07 (0.83)	4.3 (1.0)
UT13. (a)(4) IxC	10	80 (20)	22/144	184.47 (111.81)	184/117	0.14 (4.89)	5.6 (1.4)
UT14. (b)(3) ePrescribe	10	80 (20)	6/27	67.95 (49.44)	68/13	0.20 (1.26)	49.0 (21.5)

Overall Satisfaction Ratings

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks. You can be very pleased if you get an average SUS score above 83 (which is the 94th percentile of this distribution).

Table 11. System Usability Survey Scores by Nurse and Physician.

Population	Score
Average Score Overall	49

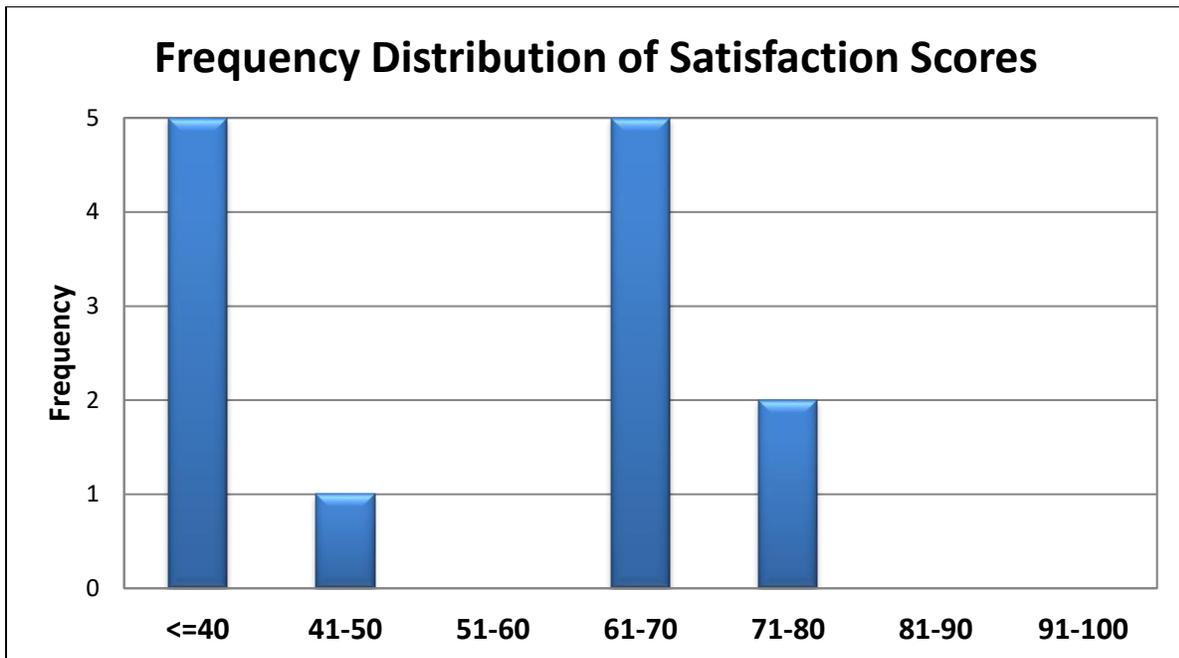


Figure 1. Satisfaction Scores from SUS (13 participants).

DISCUSSION OF FINDINGS

Most of the deviations and task failures were related to a baseline level of lostness while working through tasks with new functional capabilities or due to various technical system issues including but not limited to: diagnosis association and the inability to complete a cancel/DC.

The highest impact problem identified was in relation to Workflow 170.315(a)(1) CPOE – Medications. The task failures seen for this task were due to inability to accurately indicate a medication regimen/schedule. The medication orders were presented in the order catalog, the details were pre-defined, yet due to the number of options provided clinicians were not able to pick out the correction orderable.

Participant Comments

Selected physician comments pertaining to the covered tasks:

(a)(1) CPOE – Medications: *"It's not letting me do what I want to do."*

(a)(1) CPOE – Medications: *"I could not see that it added it when I tapped it because the keyboard icon was in the way."*

(b)(3) Electronic Prescribing: *"Don't like all this"*

(b)(3) Electronic Prescribing: *"I assume favorite's ability to save common tasks will happen, this is a pain."*

AREA(S) FOR IMPROVEMENT

Table 12. Summary of Prioritized Area(s) for Improvement.

	Priority	Criteria	Usability Finding
<u>2</u>	Medium	(a)(4) Drug-Drug/Drug-Allergy Interaction	Participants found the content in the Drug-Drug/Drug-Allergy interaction window difficult to use to make clinical decisions. Consider alternative designs for the layout and content of the interaction window.
<u>1</u>	Low	(a)(6) Problem List	Consideration should be given to redesigning the Cerner Millennium CD (Clinical) Problems to incorporate distinct steps for type of condition versus status of the condition.

APPENDIX A: DEMOGRAPHICS SURVEY

Please complete the following questionnaire to determine your eligibility to participate in the research session.

1. The research session will be a 60-minute long, one-on-one recorded session where you will interact with a system that you may or may not have used before and be asked to answer questions about your experience. Are you comfortable participating in that type of research session? Yes No
2. Have you participated in a research study with us before? Yes No
3. If you remember what the study was for, please describe it briefly below.

4. Background Information

Name: _____

Clinic or Hospital of Employment: _____

Medical Specialty: _____

Job Title: _____

Email Address: _____

Background Information

5. What is your age?
20 to 29
30 to 39
40 to 49
50 to 59
60 to 69
70 or older
6. What is your Highest level of education attained?
Trade/Technical/Vocational Training

Associate Degree

Bachelor's Degree

Master's Degree

Doctorate Degree

7. Do you currently work with Cerner PowerChart or FirstNet? Yes No

8. In your current role, how frequently do you see patients (both inpatient and outpatient)?

Daily

Multiple times a week

Once a week

Less than once a week

Never

9. How long have you been working with Cerner PowerChart or FirstNet?

Less than 1 year

1-5 years

6-10 years

Greater than 10 years

10. How comfortable are you using computers for Cerner PowerChart or FirstNet?

Not very comfortable	Somewhat uncomfortable	Neutral	Somewhat comfortable	Very comfortable
1	2	3	4	5

11. How frequently do you use a computer for Cerner PowerChart or FirstNet?

Daily	Several times/week	Weekly	Monthly	Never
1	2	3	4	5

12. How many years have you been in practice (NOT including medical school)?

13. How many years have you used an electronic health record (including medical school)?

APPENDIX B: PARTICIPANT BRIEFING/DEBRIEFING

PARTICIPANT BRIEFING

CONSENT FORM CONTENT

I'd like to remind you that your participation is entirely voluntary and you are free to end our session at any time. This session is being videotaped so that I can capture your hand gestures while using the prototype. Your name will not be associated with the recording, and will not be directly associated with any of your comments.

SESSION PROCEDURES

Our session today is scheduled for 60 minutes but shouldn't take that long. During that time, you will take a look at an electronic health record system. This study will consist of a series of tasks to perform with this system. 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. However, I want to remind you that we are testing the system not you or your abilities. If there are situations where you would seek HELP indicate those to me as the facilitator. Please save your detailed comments until the end of the session as a whole when we can discuss freely.

The instructions for each task will be displayed prior starting the task. Once you are ready, select the Start Task button and work through the task. When you think you are done with a task select the End Task button. The instructions for each task can be hidden and shown at any point while working through the tasks by selecting the Instructions button. As you work through the activities for our session today you may notice that some of the data is incomplete compared to what you might usually encounter as we have only included the minimal information to complete the activities in the patient charts.

We are recording the audio and screenshots of our session today. All of the information that you provide will be kept confidential and your name will not be associated with your comments at any time. Recording the session allows me to focus more on talking with you and less on taking notes because I can review the tape if necessary.

Do you have any questions before we begin?

PARTICIPANT DEBRIEFING

That covers all of the specifics today - do you have any general questions or comments about this software or this session that you'd like to share?

Administer the System Usability Scale.

APPENDIX C: TEST SCRIPT FOR PHYSICIANS

Scenario: A 65-year-old male was admitted to the ICU for increased difficulty with breathing and signs of volume overload. The patient reported that he has developed worsening dyspnea on exertion (only able to walk ½ block before becoming short of breath). He has gained 5 lbs. recently and is experiencing ankle swelling at night. He also reports decreased appetite. He says he has not missed any of his medications or made any recent changes to his diet. Additionally, he denies chest pain, fevers, palpitations, ICD shocks, or increased orthopnea.

You will be starting out by opening the Patient's chart. Confirm that you have opened the correct patient.

Optimal Path: Select patient from physician list > View demographics banner

1. **(170.315(a)(6) Problem List)** During your discussion the patient informed you that he no longer has insomnia. Review and update the problem list.

Optimal Path: View problems > Select Resolve next to Insomnia

EoU-1. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of resolving a problem?

3. **(170.315 (a)(1) CPOE – Medications, (a)(4) Drug-Drug Interaction Checking)** Revise the Lasix order to 80mg and increase the frequency to BID. What is this alert informing you of? What would expect to be your next steps? For this scenario go ahead and keep all orders.

Optimal Path: Select Lasix order > select discontinue > Select Search > search for Lasix 80mg > add order > Alert appears > Keep both orders > sign orders (optional)

EoU-3. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of responding to interaction checking dialog(s)?

5. **(170.315(a)(2) CPOE - Labs)** Order labs to determine if patient is having a heart attack.

Optimal Path: Up to user to determine which labs. If user requests which labs to order, prompt with Creatinine Kinase – Total and MB, Troponin I/T, Electrocardiogram (EKG) > In Add Order Search window > search for and add to the scratchpad by selecting the order name from the search results > Ensure that the order details conform to the information provided > Click Sign (optional)

EoU-5. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of ordering labs?

6. **(170.315(a)(3) CPOE - Imaging)** You would also like to evaluate the patient's condition further with some imaging. Order the following imaging studies: XR Chest 2 Views and TTE
Optimal Path: Using the Add Order Search window > search for and add to the scratchpad by selecting the order name from the search results > Ensure that the order details conform to the information provided > Click Sign (optional)

EoU-6. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of ordering imaging?

Scenario: As Dr. Branson, a Heart Mate II LVAD insertion procedure has now been performed for <patient name> and you have finished a post-operative exam of the patient. [Open Problems]

10. **(170.315(a)(6) Problem List)** You need to add to the patient's problem list following the procedure. Add Anemia due to blood loss and Hyponatremia with a comment of "Trend, volume overloaded. No further bolus."

Optimal Path: Enter problem in Search field > Anemia > Enter details (status = active; Onset = postoperative) > Done > Enter problem in Search field > Hyponatremia > Enter details (Status = Active; Onset = postoperative; Comment: Trend, volume overloaded. No further bolus.)

EoU-10. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of adding a problem?

11. **(170.315(a)(7) Medication List, (b)(3) Electronic Prescribing)** Review the patient's medication list from his last visit. Does <patient> need any refills?

Optimal Path: review medication list > levothyroxine is overdue for a refill

EoU-11. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of reviewing the medication list?

12. **(170.315(a)(1) CPOE - Medications)** Add the following Coumadin regimen:

Coumadin 5 mg BID on Mon, Wed, Fr

Coumadin 7.5 mg daily on Tue, Thur, Sat and Sun

Optimal Path:

EoU-12. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of prescribing medications?

13. (170.315(a)(4) Drug-Drug Interaction Checking) Include an order for Oxycodone/Acetaminophen 5/325 (Percocet) 1 Tab PO Q4H PRN for Pain. What is this alert informing you of? What would expect to be your next steps? For this scenario go ahead and keep Percocet prescription but remove the aspirin.

Optimal Path:

EoU-13. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of responding to interaction checking dialog(s)?

14. (170.315(b)(3) Electronic Prescribing) Confirm that the medications will be routed electronically to the patient's preferred pharmacy. How would you indicate that a prescription should be routed to the patient's pharmacy?

Optimal Path:

EoU-14. On a scale from 1 to 7, with 1 being very difficult to 7 being very easy, rate the task of responding to interaction checking dialog(s)?

15. Overall what aspects of this software could be improved and/or are especially effective?