

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

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

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EXECUTIVE SUMMARY

A usability test of Cerner's FirstNet (Clinical) was conducted on remotely on Dec. 12, 2016 through Jan. 7, 2017 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, 24 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:

- Find information in Patient Summary screen
- Add, Remove and Edit the Problem List
- Review Vitals and Labs
- Add, Remove and Edit the Medication Allergy List
- Add, Remove and Edit the Medication List
- Reconcile outside records with the Patient's chart
- Review the Patient's implanted device list
- Add, Remove and Edit Physician Orders, and if relevant, route them to the patient's preferred pharmacy

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)
MD1. (a)(5) Demographics	13	92 (0.28)	11 / 5	96.77 (71.46)	58 / 51	0.8 (1.0)	6.2 (1.2)
MD2. (b)(2) CIR: Problems	13	77 (0.44)	130 / 6	408.97 (271.22)	512 / 30	10.0 (5.6)	3.5 (1.3)
MD3. (a)(6) Problem List	13	100 (0)	4 / 2	69.22 (51.41)	26 / 44	0.3 (0.6)	6.3 (0.9)
MD4. (a)(7) Meds List & (b)(2) CIR: Medication List	13	69 (0.48)	34 / 9	281.27 (242.99)	364 / 36	2.6 (2.5)	4.2 (1.7)
MD5. (a)(4) Drug-Drug IxC	10	90 (0.32)	4 / 4	26.13 (24.52)	7 / 21	0.3 (0.9)	4.2 (1.5)
MD6. (a)(7) Meds List	13	92 (0.28)	12 / 4	106.26 (126.74)	80 / 31	0.9 (1.3)	5.8 (0)
MD7. (a)(1) CPOE	13	100 (0)	6 / 5	78.52 (66.19)	41 / 38	0.5 (0.8)	5.7 (1.4)
MD8. (a)(1) CPOE	13	92 (0.28)	9 / 5	98.53 (51.23)	90 / 48	0.7 (1.1)	5.6 (1.2)
MD10. (a)(3) CPOE Imaging	13	92 (0.28)	15 / 9	150.61 (63.12)	95 / 67	1.2 (1.4)	6.0 (0.8)
MD11. (a)(2) CPOE Labs	13	92 (0.28)	12 / 5	8.74 (11.11)	7 / 2	0.9 (0.9)	6.0 (1.4)
MD12. (a)(14) Device List	12	100 (0)	34 / 4	165.40 (115.05)	165 / 0	2.6 (1.8)	4.6 (2)
MD14. (a)(6) Problem List	13	92 (0.28)	14 / 6	144.45 (50.50)	110 / 42	1.1 (1.0)	6.1 (0.9)
MD15. (a)(1) CPOE, (b)(2) CIR: Medication List, & (b)(3) eRx	13	92 (0.28)	36 / 7	283.30 (152.78)	271 / 28	2.8 (2.2)	5.2 (0)
MD16. (b)(3) eRx	13	100 (0)	2 / 3	121.78 (63.11)	25 / 97	0.2 (0.4)	5.2 (1.5)

RN1. (a)(5) Demographics	11	73 (0.47)	49 / 7	179.16 (154.93)	228 / 33	4.45 (4.55)	3.4 (1.8)
RN2. (a)(8) Med-Allergy List	11	91 (0.30)	9 / 8	93.00 (54.57)	53 / 39	0.82 (0.87)	5.8 (1.1)
RN3. (b)(2) CIR: Allergy List	11	73 (0.47)	37 / 5	154.38 (112.94)	132 / 24	3.36 (2.11)	4.8 (1.7)
RN4. (b)(2) CIR: Problem List	11	64 (0.50)	46 / 4	178.07 (208.82)	194 / 8	3.09 (2.39)	4.6 (1.5)
RN5. (a)(7) Med List	11	100 (0)	5 / 6	84.31 (16.45)	20 / 61	0.45 (0.93)	5.8 (1.8)
RN6. (a)(7) Med List	11	91 (0.30)	18 / 8	122.71 (59.88)	106 / 6	1.64 (1.63)	5.0 (1.5)
RN7. (a)(4) IxC & (a)(8) Med-Allergy List	11	91 (0.30)	6 / 12	88.62(42.14)	46 / 61	0.64 (0.92)	6.2 (0.9)
RN9. (a)(14) Device List	10	30 (0.42)	53 / 4	59.18 (127.66)	207 / 0	5.30 (4.19)	3.5 (1.4)

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be: 54 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 lustiness while working through tasks with new functional capabilities or due to configuration artifacts of the usability testing.
- The highest impact problem identified was in relation to Workflow 170.315(b)(2) Clinical Information Reconciliation when performing medication reconciliation. The errors for these tasks pertained to the duplication of Discern Alerts associated with the warfarin regimen. Cerner's Discern Alerts depend on configuration by the client to ensure they are well designed for the type of care and venue within the facility. Proper configuration and a balanced alerting hierarchy by the organization will mitigate this usability issue.
- The second high impact problem identified was in relation to Workflow 170.315(a)(14) Implanted Device when reviewing modifying device data. The high error rate for this task pertained to the default display provided for the test device. Mitigation for these problems can be achieved through display rules for the device type.

- A additional high impact problem regarding Workflow 170.315(a)(4) Drug-Drug/Drug-Allergy Interaction Checking was found to be related to the layout and content of the alert messages. The physicians were observed having difficulty performing a clinical decision based on a lack of visual differentiators indicating the priority and type of alert. Proper configuration and a balanced alerting hierarchy by the organization will mitigate this usability issue.

INTRODUCTION

The purpose of this document is to report on summative testing performed by Cerner Corporation to evaluate the usability of its FirstNet (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.

A total of 24 participants were tested on FirstNet (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.)	Product Experience (Yrs.)	Computer Experience (Yrs.)	Computer Proficiency*	Assistive Technology Needs
1	0251	MD	Psychiatry	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Female	50-59	30	6	6	5	No
2	0546	MD	Emergency Medicine	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	50-59	15	10	12	5	No
3	0850	RN	Critical Care	Associate degree	Male	30-39	19	10	19	5	No
4	1158	MD	OB/GYN	Master's Degree	Male	40-49	19	1	3	5	No
5	1436	MD	Family Practice	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Female	40-49	11	6	8	5	No
6	1606	MD	Surgery	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	40-49	28	1	10	5	No
7	1666	MD	Emergency Medicine	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	30-39	16	1	16	5	No
8	1744	MD	Internal Medicine	Doctorate degree (e.g.,	Male	60-69	40	1	3	4	No

				MD, DNP, DMD, PhD)							
9	1745	MD	Pediatrics	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	40-49	20	0	<1	4	No
10	1746	MD	Neurology	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	50-59	30	10	11	5	No
11	1748	MD	Emergency Med.	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	30-39	13	6	17	5	No
12	1749	MD	Am. Internal Med.	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	50-59	32	10	20	4	No
13	1750	MD	Family Medicine	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Female	20-29	5	0	5	3	No
14	1751	MD	Family Medicine	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Male	50-59	25	6	11	1	No
15	1753	RN	Nursing	Associate degree	Female	40-49	20	0	5	5	No
16	1754	RN	Medical/Surgical	Associate degree	Female	60-69	40	10	12	5	No
17	1755	RN	Medical/Surgical	Associate	Female	30-39	13	6	6	5	No

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				degree							
18	1756	RN	Family Medicine	Some college credit, no degree	Female	20-29	4	0	10	5	No
19	1757	RN	Ped. Critical Care	Associate degree	Female	30-39	19	6	6	5	No
20	1758	RN	Medical/Surgical	Associate degree	Female	30-39	6	1	5	5	No
21	1759	RN	Nursing	Associate degree	Female	50-59	25	6	10	4	No
22	1762	RN	Critical Care Nursing	Associate degree	Male	40-49	23	1	6	4	No
23	1763	RN	Pediatrics	Associate degree	Female	40-49	21	6	10	5	No
24	1765	RN	ICU/Acute Care	Associate degree	Female	20-29	7	1	7	5	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 FirstNet (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 FirstNet (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, the recording was paused and resumed following any interruptions. 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 December 12, 2016 to January 7, 2017.

Test Location and Environment

Remote desktop testing was conducted on a remote desktop using a screen sharing application. The participants used a mouse and keyboard 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 & D)

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. Any data exclusions or details of testing irregularities that affected data collection are indicated in each section below. 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 MD7, MD8, and MD15) in which they ordered medications or revised existing medication orders.

	MD7	MD8	MD15
Task Success Rate	100%	92%	100%
Task Failure Rate	0%	8%	0%
Deviation Rate	9%	14%	5%
Average User Rating	5.7	5.6	5.2

Usability Results for Task

Cerner FirstNet (Clinical) provides configuration options for the end-user personally and for the facility generally. Participants were warned not to expect to find their personal favorites or even the departmental picklists that they were accustomed to using in their daily practice. As a result, they worked a bit slower than usual while learning how medication orders were organized in the testing environment. Participating physicians did not encounter any difficulties in either finding, ordering, or revising the patient's medications. However, only one of the physicians demonstrated their knowledge of the provider view functionality and performed the task using the optimal method through the provider workflow component.

The task failure seen for Task MD8 was due to placing duplicate orders that were not resolved through the duplicate order alert to remove the duplicate order. In fact, three physicians were observed placing duplicate orders, of which two caught the mistake and corrected it before signing the orders.

The remaining errors represented 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.

Usability Findings for Task

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1. **Low Priority:** Ensuring default configuration for duplicate order alerts within a conscious balance of alerting hierarchy will prevent users from experiencing alert fatigue. [[TABLE 5. Finding ID 1.](#)]

Workflow 170.315 (a) (2) CPOE Imaging

Participating physicians were asked to order two different imaging studies (see task MD10): chest x-ray and transthoracic echocardiogram (TTE).

	MD10
Task Success Rate	92%
Task Failure Rate	8%
Deviation Rate	13%
Average User Rating	6.0

Usability Results for Task

The task failure seen for task MD10 was due to a physician not placing the second imaging study for a transthoracic echocardiogram. Alternatively, two other physicians were observed placing a clinically similar but more complex order to the transthoracic echocardiogram.

The most common error was around 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 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 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 MD11). 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).

	MD11
Task Success Rate	92%
Task Failure Rate	8%

Deviation Rate	18%
Average User Rating	6.0

Usability Results for Task

The task failure seen for Task MD11 was due to a physician not placing lab orders representative of the clinically relevant orders identified as part of the task. In this instance the physician selected a lab order based on a clinical diagnostic for chest pain instead of the CHF problem as described.

The most common error was around potential delays in care by not including a STAT priority for the lab order. Alternatively, two physicians were observed selecting a Point of Care orderable for the lab.

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) (4) Drug – Drug / Drug – Allergy Interaction Checking

Participating physicians were assigned a reconciliation task in which they ordered medications or revised existing medication orders. In this task, one or more of the orders generated an alert for drug to drug interaction (MD5). Participating nurses were assigned a task in which they added an allergy that would generate an alert for an interaction with an existing, active medication order (RN7).

	MD5	RN7
Task Success Rate	90%	73%
Task Failure Rate	10%	27%
Deviation Rate	8%	5%
Average User Rating	4.2	4.6

Usability Results for Task

The task failure seen for Task MD5 was due to a physician continuing through the alert without reviewing the alert content. In this instance the physician selected continue for the alert immediately upon encountering the alert (occurring within 4 seconds), which was more than 2 standard deviations outside the time that would be expected for full processing of the alert to occur.

The most common error encountered by the physicians was around confusing a drug-drug interaction alert for a drug-allergy interaction alert and searching for more details around allergies. As indicated by one of the physicians, “I don't remember if he's got an allergy or if it's because he's on aspirin as a dose...”.

The task failure seen for task RN7 was due to the entry of the allergy and not to the relationship with the medication list. Due to the confounding relationship to the allergy entry steps and system configuration errors, two of the participants did not receive the reverse allergy checking alert. Of the remaining nine nurses, only one of the nurses was observed reviewing the indication of the reverse allergy check. This interaction alert is presented as a passive notification to the nurse in this workflow step and is not frequently encountered in a typical workflow.

The most common error associated with task RN7 was entering the allergy and/or reaction as free text instead of using the codified search terms.

Usability Findings for Task

2. **High 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 5. Finding ID 2.](#)]
3. **High Priority:** Participants did not notice a passive reverse interaction check alert with the allergy workflow. Improve the alert information to increase noticeability. [[TABLE 5. Finding ID 3.](#)]

Workflow 170.315 (a) (5) Patient Demographics

Patient demographics were tested through a two-part task in this workflow. As the first task of their session, all the participants were asked to confirm that they had opened the correct patient's electronic record and to point out which data elements on screen they used to do this. The other part of the task for this workflow was assigned to nurses only and involved updating the patient's preferred language.

	MD1	RN1
Task Success Rate	92%	73%
Task Failure Rate	8%	27%
Deviation Rate	17%	64%
Average User Rating	6.2	3.4

Usability Results for Task

The task failure seen for task MD1 was due to a physician opening the incorrect patient chart and not performing 'right patient' steps. Most of the participants either selected the patient from the patient list or searched for the patient using the patient search dialog. Neither of those workflows employ the Name Alert configuration for indicating duplicate names as would be available from a physician handoff or other worklist view.

Cerner FirstNet (Clinical) provide the capability for clinicians to update specific demographic information for patients. However, it is known that most client sites have policies indicating that this should be done only via the registration system and not in the EHR solution. Comments from the participants showed that this was the case for most of the participating clinicians.

The task failure seen for task RN1 was due to nurses having difficulty completing the second portion of the task. Nurses were observed having difficulty finding the correct admissions form with the preferred language options and/or finding the preferred language options within the form. Only three of the nurses were observed reviewing the registration application information for indicating the preferred language.

Usability Findings for Task

4. **Medium Priority:** While the most common workflow is to choose the patient from a worklist screen, non-frequent and interruptive task flows could require using the patient list or search screens. Recommend including the duplicate name alert functionality in all forms or screens in which a patient is accessed within Cerner FirstNet (Clinical). [[TABLE 5. Finding ID 4.](#)]
5. **Low Priority:** Consideration should be given to redesigning the Cerner FirstNet (Clinical) Patient Demographics assessments to enhance its readability and make it easier for end-users to locate the desired data entry fields. [[TABLE 5. Finding ID 5.](#)]

Workflow 170.315 (a) (6) Problem List

Participating physicians were asked to both update an existing problem as resolved (see task MD3) and to add two new problems (see task MD14).

	MD3	MD14
Task Success Rate	100%	92%
Task Failure Rate	0%	8%
Deviation Rate	15%	18%

Average User Rating	6.3	6.1
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Usability Results for Task

The task (MD3) for updating an existing problem followed directly after the task of reconciling the problem list and involved updating the status of a problem imported from a CCDA document. Only one of the physicians demonstrated their knowledge of the provider view functionality and performed the task using the optimal method through the provider workflow component. The remaining physicians performed the problem resolution task through the diagnoses and problems chart view.

The most common error identified for task MD3 was due to the workflow steps completed in the previous task. Three physicians were observed declining to add the Insomnia/Sleeplessness problem from the CCDA into the chart during reconciliation as a way of ensuring that the problem was considered historic. Additionally, one physician chose to add the problem manually and then indicate the status as resolved.

The task failure seen for task MD14 was due to a physician not including one of the two new problems as part of the task.

The most common error identified for task MD14 was for physicians to select the simplest form of anemia and not include the information that it was due to blood loss. However, one physician was observed adding the ‘due to blood loss’ as part of the problem comments.

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. All of the physicians whom performed the problem resolution task using the diagnoses and problems chart view were again observed using the same workflow steps for this task.

Usability Findings for Task

- 6. **Low Priority:** Update the client-facing implementation documentation so that clients are encouraged to use the more usable provider view workflow option. [\[TABLE 5. Finding ID 6.\]](#)

Workflow 170.315 (a) (7) Medications List

Participating physicians and nurses were asked to prepare the patient’s home medications list (see task MD4 and RN5) and then make changes to the data in the list (see task MD6 and RN6).

	MD4	MD6	RN5	RN6
Task Success Rate	69%	92%	100%	91%

Task Failure Rate	31%	8%	0%	9%
Deviation Rate	29%	23%	8%	20%
Average User Rating	4.2	5.8	5.8	5.0

Usability Results for Task

The task (MD4) for modifying a medication within the existing medication list was embedded within the task of reconciling the medication list during an admission reconciliation. Two of the task failures were due to participants who did not complete the order transfer into the inpatient venue for all of the medications on the list. These failures are discussed in more detail under Workflow 170.315 (b) (2) Clinical Information Reconciliation for medications below. The remaining two failures were situations in which the physician did not modify the orderable with the correct order details.

The most common error identified for task MD4 related to the medication list modification was related to searching for the new orderable within the inpatient venue instead of as a documented medication. The remaining errors were more closely related to the clinical information reconciliation portion of the task.

The task failure seen for task MD6 was due to a physician selecting the incorrect orderable from the search options list. Eleven of the participating physicians selected the medication from the medication orderable window instead of the search drop-down and decreased the distinguishability between orderables.

The most common error identified for task MD6 was related to searching for the new orderable within the inpatient venue instead of as a documented medication. Additional errors were associated with opening and closing the add order dialog without performing a search and selecting the blank orderable, requiring additional steps to complete the task. None of the physicians were observed performing the medication history update from the provider workflow component, contributing to the inability to distinguish venue within the add order dialog.

The errors associated with RN5 were related to the recency of the previous tasks to review the outside record for allergy and problem reconciliation; the nurses attempted to perform the updates to the medication list from the outside record reconciliation view.

The most common errors associate with RN6 were due to the nurse attempting to modify a prescription to change the documented dose. For this test, Cerner FirstNet (Clinical) was configured so that documented dose changes required that the previous prescription be

cancelled and that a new prescription be documented for the new dosage of the medication. This configuration of the workflow contributed to 56% of the errors observed for this task.

Usability Findings for Task

7. **Low Priority:** Update the client-facing implementation documentation so that clients are encouraged to use the more usable provider view workflow option. [\[TABLE 5. Finding ID 7.\]](#)

Workflow 170.315 (a) (8) Allergy List

Participating nurses were asked to update the reaction and its severity for one of the allergies in the patient’s allergy list (RN2) and add a new allergy to the allergy list (RN7).

	RN2	RN7
Task Success Rate	91%	91%
Task Failure Rate	9%	9%
Deviation Rate	10%	5%
Average User Rating	5.8	6.2

Usability Results for Task

The task failure seen for task RN2 was due to a nurse entering the reaction in the comments section rather than entering a codified reaction.

The most common error associated with task RN2 was entering the reaction as free text instead of using the codified search term. Additional errors were associated with canceling the original reaction documented for the allergy.

The task failure seen for task RN7 was due to a similar error as seen for RN2 in which the nurse entered the reaction in the wrong field. In this case, the nurse entered the reaction in the “Reported on behalf of” field. No codified term was entered for the reaction by this nurse.

The most common error associated with task RN7 was entering the allergy and/or reaction as free text instead of using the codified search terms. Additional errors were associated with entering the allergy in the wrong field within the allergy dialog.

Usability Findings for Task

8. **Medium Priority:** Consider improving the layout and flow of the allergy screen to reduce steps. [\[TABLE 5. Finding ID 8.\]](#)

Workflow 170.315 (a) (14) Implant Device List

Cerner’s FirstNet (Clinical) capability to capture Unique Device Identifiers (UDI) for Implanted Devices is new with this software release; therefore, no participant was familiar with the capability. Further, clinical processes will most likely capture this information by surgical and interventional staff using their systems and flows. Therefore, due to the point and type of workflow that would generally be expected for this information participating physicians performed a review only task (see task MD12) and nurses performed a review and update task (see task RN9).

	MD12	RN9
Task Success Rate	100%	30%
Task Failure Rate	0%	70%
Deviation Rate	65%	133%
Average User Rating	4.6	3.5

Usability Results for Task

As the Implanted Device list is new functionality all of the physicians and nurses had to be directed as to the navigation steps to access the Implants view within the Histories portion of the chart.

The most common errors observed for task MD12 were committed by eight of the physicians whom did not review the non-biological implant information to confirm the implant details tied to that view. As the implant device view was defaulted to biologic implant type the fields displayed in the detailed view did not include lot number, etc. However, several of the same physicians did review the implant information in the table view which did display those details.

As the implanted device data for task RN9 was entered into the system prior to the test, the details tied to the non-biological implant type field were not viewed face up in the record edit view. This included the field for the manufacturer which was the incorrect data within the record. All of the failures for this task were due to the nurses not viewing the details tied to the non-biologic implant type since the display defaulted to biological implant type fields.

The most common error for task RN9 was for nurses to have difficulty navigating to the implanted devices view within histories.

The high number of errors seen for nurses versus physicians is due to the nature of the task steps according to ownership of the workflow task. Since physicians were provided with a strictly review-only task, there were fewer opportunities for error and hence a higher success

signal. The nursing task required edit steps which increase the opportunities for error and hence increased the error rate.

Usability Findings for Task

9. **High Priority:** Improve detail findability by defaulting the detail view according to the implant device type. [\[TABLE 5. FINDING ID 9.\]](#)

Workflow 170.315 (b) (2) Clinical Information Reconciliation

Cerner FirstNet (Clinical) provide reconciliation capabilities for the following clinical information from external C-CDA sources: Allergies Reconciliation, Medications Reconciliation, Problems Reconciliation, and Immunizations Reconciliation (see task MD2, RN3, and RN4). For this usability study, the test environment was configured for Allergies, Medications, and Problems. Additionally, Cerner FirstNet (Clinical) provide medication reconciliation workflows for admission, transfer, and discharge across venues (see task MD4 and MD15).

Participants were unfamiliar with Reconciliation tasks from outside records as reconciling from external sources, including C-CDAs has not been implemented at the participating sites.

	MD2	MD4	MD15	RN3	RN4
Task Success Rate	77%	69%	92%	73%	64%
Task Failure Rate	23%	31%	8%	27%	36%
Deviation Rate	167%	29%	40%	67%	77%
Average User Rating	3.5	4.2	5.2	4.8	4.6

Usability Results for Task

Reconciling Problems from an External Record

For task MD2 the physician is told that the patient’s primary care physician has sent documentation and that there are problems to be reconciled to the patient's problem list. They are asked to choose problems to add to the patient’s problem list that are related to the current visit. As stated previously, physician participants indicated that this capability is not in use at their location and that they do not perform problem reconciliation. 20% of the errors were related to prompting participants on where to access the outside records.

The participants expected to review the documentation from the PCP rather than use the Cerner FirstNet (Clinical) capability to actively reconcile imported problems with the current problem list. In fact, 19% of the errors committed by the physician participants were related to repeated opening of the external document viewer.

Once the physicians accessed the Reconciliation view for the external problems, physicians had great difficulty figuring out how to add the external problems to the patient's problems list without moderate prompting. A common theme from comments and observations was the inability of the physicians to select all or a subset of the problems from the outside record and reconcile them with the chart. In fact, errors associated with selecting the buttons for "Complete History" or "Save to Chart" in which the physicians were expecting this type of feature accounted for 14% of the error rate observed for physicians.

All participants thought that reconciling an externally documented problem to the Patient's Current Problem list meant that the problem would be associated to the current visit vs. assigned to the patient only and requiring additional user action to indicate it is relevant to the visit. The step of selecting problems to link the current visit seemed completely redundant to the participating physicians. Only two physicians were observed performing the additional steps of adding the problems to the visit manually.

The most common task error observed for RN3 was that nurses attempted to add the problems to the chart manually instead of performing the reconcile steps for the outside records. This error contributed to 47% of the errors observed for this task. Additional errors, were associated with selecting the "Complete History" or "Save to Chart" buttons as observed during the physician sessions.

Reconciling Allergies from an External Record

For task RN4 the nursing task indicates that the patient's primary care physician has sent documentation and that there are allergies to be reconciled to the patient's medication-allergy list. As stated previously, the nurse participants indicated that this capability is not in use at their location and that they do not perform medication-allergy reconciliation from outside records.

The most common task error observed for RN4 was that nurses attempted to add the allergies to the chart manually instead of performing the reconcile steps for the outside records. This error contributed to 50% of the errors observed for this task. Additional errors, were associated with selecting the "Complete History" or "Save to Chart" buttons.

Medication Reconciliation

Physicians were asked to perform admission medication reconciliation, starting from a home medications list (see task MD4). In a follow-up task, they were also asked to make changes to the dosing information to some of the medications from the home medications. Three of the task failures identified for task MD4 were due to the physicians not continuing all of the home

medications into the inpatient venue. This resulted in a 71% success rate (29% failure rate) of completing the home medication reconciliation task. The additional task failures were related to the medication list modification task previously discussed under Workflow 170.315 (a) (7) Medications List. Additionally, these errors in MD4 resulted in participants not receiving the drug-drug interaction alert for task MD5.

All of the participating physicians completed the discharge medication reconciliation task fairly easily (see task MD15). The configuration and display of the functionality used in the test was indicated by the participants to resemble that which they use frequently and that they were comfortable with it. The task failure identified for this task was similar to that observed for MD4 in which the physicians did not continue all of the home medications during discharge.

The most common task errors observed (accounting for 42%) for MD15 were associated with the continuing or stopping the correct line of medication according to the appropriate venue of the order or prescription. In fact, two participants still continued each home medication individually instead of using the more efficient method of selecting the “Continue Home Medications” button.

Usability Findings for Task

- 10. **High Priority:** Optimize external reconciliation steps by providing the ability to reconcile or merge multiple outside record items in a batch add or decline process. [TABLE 5. Finding ID 9.]
- 11. **Medium Priority:** Consider providing more cues for adding outside record items to the chart and disabling the “Complete History” and/or “Save to Chart” buttons until all record items have been added or declined. [TABLE 5. FINDING ID 11.]
- 12. **Low Priority:** Consider a system default association between the current visit and the active, reconciled problems. [TABLE 5. Finding ID 11.]
- 13. **Low Priority:** Consider providing clearer indications as to which line item orderable pertains to which venue. [TABLE 5. Finding ID 13.]

Workflow 170.315 (b) (3) Electronic Prescribing

Participating physicians were asked to prepare the patient’s home medications and indicate how they would ensure that any new prescriptions would be sent to the patient’s preferred pharmacy.

	MD15	MD16
Task Success Rate	92%	100%

Task Failure Rate	8%	0%
Deviation Rate	40%	5%
Average User Rating	5.2	5.2

Usability Results for Task

All of the participating physicians completed the discharge medication reconciliation task fairly easily (see task MD15). The task failure identified for this task was related to the reconciliation task itself and not with electronic prescribing steps. Only 25% of the errors observed for this task were related to the electronic prescribing steps.

The task (MD16) for ensuring the new prescriptions would be sent to the patient’s preferred pharmacy immediately followed the discharge medication reconciliation task and therefore certain errors could contribute to the ability to understand and complete this task. 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, all 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 3. Effectiveness, Efficiency, and Satisfaction Scores for FirstNet.

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)
MD1. (a)(5) Demographics	13	92 (0.28)	11 / 5	96.77 (71.46)	58 / 51	0.8 (1.0)	6.2 (1.2)
MD2. (b)(2) CIR: Problems	13	77 (0.44)	130 / 6	408.97 (271.22)	512 / 30	10.0 (5.6)	3.5 (1.3)
MD3. (a)(6) Problem List	13	100 (0)	4 / 2	69.22 (51.41)	26 / 44	0.3 (0.6)	6.3 (0.9)
MD4. (a)(7) Meds List & (b)(2) CIR: Medication List	13	69 (0.48)	34 / 9	281.27 (242.99)	364 / 36	2.6 (2.5)	4.2 (1.7)
MD5. (a)(4) Drug-Drug IxC	10	90 (0.32)	4 / 4	26.13 (24.52)	7 / 21	0.3 (0.9)	4.2 (1.5)
MD6. (a)(7) Meds List	13	92 (0.28)	12 / 4	106.26 (126.74)	80 / 31	0.9 (1.3)	5.8 (0)
MD7. (a)(1) CPOE	13	100 (0)	6 / 5	78.52 (66.19)	41 / 38	0.5 (0.8)	5.7 (1.4)
MD8. (a)(1) CPOE	13	92 (0.28)	9 / 5	98.53 (51.23)	90 / 48	0.7 (1.1)	5.6 (1.2)
MD10. (a)(3) CPOE Imaging	13	92 (0.28)	15 / 9	150.61 (63.12)	95 / 67	1.2 (1.4)	6.0 (0.8)
MD11. (a)(2) CPOE Labs	13	92 (0.28)	12 / 5	8.74 (11.11)	7 / 2	0.9 (0.9)	6.0 (1.4)
MD12. (a)(14) Device List	12	100 (0)	34 / 4	165.40 (115.05)	165 / 0	2.6 (1.8)	4.6 (2)
MD14. (a)(6) Problem List	13	92 (0.28)	14 / 6	144.45 (50.50)	110 / 42	1.1 (1.0)	6.1 (0.9)
MD15. (a)(1) CPOE, (b)(2) CIR: Medication List, & (b)(3) eRx	13	92 (0.28)	36 / 7	283.30 (152.78)	271 / 28	2.8 (2.2)	5.2 (0)
MD16. (b)(3) eRx	13	100 (0)	2 / 3	121.78 (63.11)	25 / 97	0.2 (0.4)	5.2 (1.5)
RN1. (a)(5) Demographics	11	73 (0.47)	49 / 7	179.16 (154.93)	228 / 33	4.45 (4.55)	3.4 (1.8)
RN2. (a)(8) Med-Allergy List	11	91 (0.30)	9 / 8	93.00 (54.57)	53 / 39	0.82 (0.87)	5.8 (1.1)
RN3. (b)(2) CIR: Allergy List	11	73 (0.47)	37 / 5	154.38 (112.94)	132 / 24	3.36 (2.11)	4.8 (1.7)
RN4. (b)(2) CIR: Problem List	11	64 (0.50)	46 / 4	178.07 (208.82)	194 / 8	3.09 (2.39)	4.6 (1.5)
RN5. (a)(7) Med List	11	100 (0)	5 / 6	84.31 (16.45)	20 / 61	0.45 (0.93)	5.8 (1.8)

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RN6. (a)(7) Med List	11	91 (0.30)	18 / 8	122.71 (59.88)	106 / 6	1.64 (1.63)	5.0 (1.5)
RN7. (a)(4) IxC & (a)(8) Med-Allergy List	11	91 (0.30)	6 / 12	88.62(42.14)	46 / 61	0.64 (0.92)	6.2 (0.9)
RN9. (a)(14) Device List	10	30 (0.42)	53 / 4	59.18 (127.66)	207 / 0	5.30 (4.19)	3.5 (1.4)

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 4. System Usability Survey Scores by Nurse and Physician.

Population	Score
Average Score Overall	54
Average Score for Physicians	56
Average Score for Nurses	51

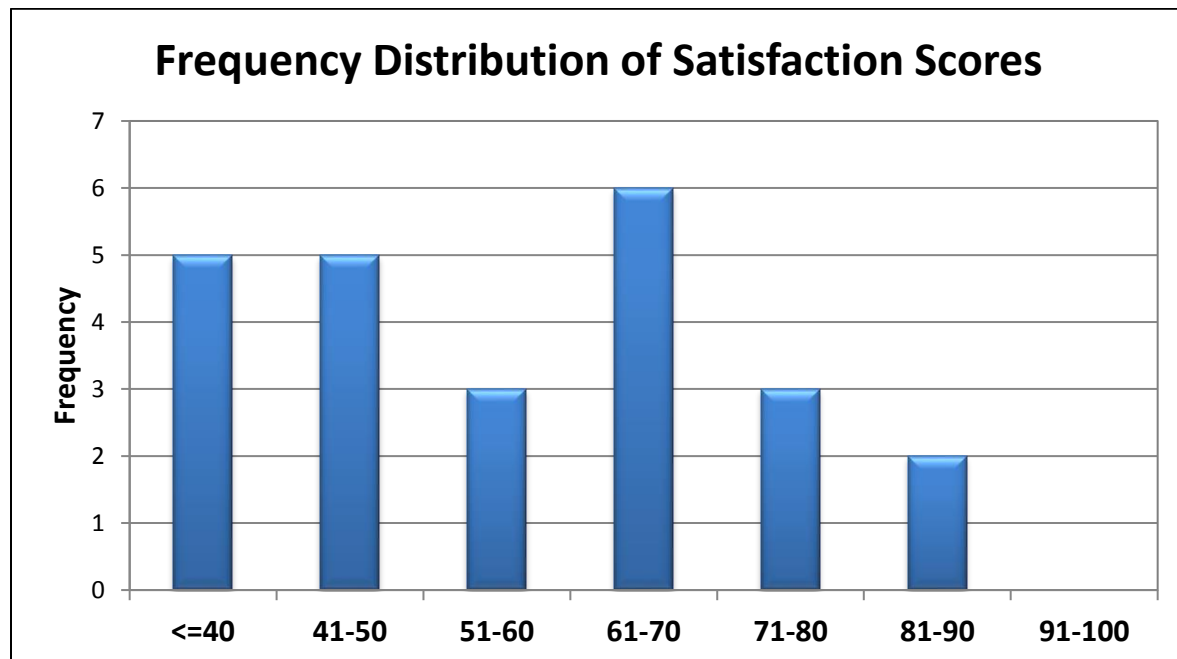


Figure 1. Satisfaction Scores from SUS (24 participants).

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 configuration artifacts of the usability testing. The three high impact problems identified through this testing are related to tasks and workflow associated with Workflow 170.315(a)(4) Drug-Drug/Drug-Allergy Interaction Checking, Workflow 170.315(a)(14) Implanted Device, and Workflow 170.315(b)(2) Clinical Information Reconciliation tasks.

The highest impact problem identified was in relation to Workflow 170.315(b)(2) Clinical Information Reconciliation when performing medication reconciliation. The errors for these tasks pertained to the duplication of Discern Alerts associated with the warfarin regimen. Cerner's Discern Alerts depend on configuration by the client to ensure they are well designed for the type of care and venue within the facility. Proper configuration and a balanced alerting hierarchy by the organization will mitigate this usability issue.

The second high impact problem identified was in relation to Workflow 170.315(a)(14) Implanted Device when reviewing modifying device data. The high error rate for this task pertained to the default display provided for the test device. Mitigation for these problems can be achieved through display rules for the device type.

An additional high impact problem regarding Workflow 170.315(a)(4) Drug-Drug/Drug-Allergy Interaction Checking was found to be related to the layout and content of the alert messages. The physicians were observed having difficulty performing a clinical decision based on a lack of visual differentiators indicating the priority and type of alert. Proper configuration and a balanced alerting hierarchy by the organization will mitigate this usability issue.

Participant Comments

The most common physician comments pertained to the Workflow 170.315(b)(2) Clinical Information Reconciliation tasks:

"Why do I have to ignore the same alert twice?"

"If I order the same med twice you should not have to respond to the same alert."

"It doesn't use the exact same wording so...I'm a little concerned about cluttering up my problem list."

“If I wanted to do this easy way I would hold down shift and hit the bottom [problem].”

AREA(S) FOR IMPROVEMENT

Table 5. Summary of Prioritized Area(s) for Improvement.

	Priority	Criteria	Usability Finding
1	Low	(a)(1) CPOE Medications	Ensuring default configuration for duplicate order alerts within a conscious balance of alerting hierarchy will prevent users from experiencing alert fatigue.
2	High	(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.
3	High	(a)(4) Drug-Drug/Drug-Allergy Interaction	Participants did not notice a passive reverse interaction check alert with the allergy workflow. Improve the alert information to increase noticeability.
4	Medium	(a)(5) Demographics	While the most common workflow is to choose the patient from a worklist screen, non-frequent and interruptive task flows could require using the patient list or search screens. Recommend including the duplicate name alert functionality in all forms or screens in which a patient is accessed within Cerner PowerChart and FirstNet.
5	Low	(a)(5) Demographics	Consideration should be given to redesigning the Cerner FirstNet (Clinical)Patient Demographics assessments to enhance its readability and make it easier for end-users to locate the desired data entry fields.
6	Low	(a)(6) Problem List	Update the client-facing implementation documentation so that clients are encouraged to use the more usable provider view workflow option.
7	Low	(a)(7) Medication List	Update the client-facing implementation documentation so that clients are encouraged to use the more usable provider view workflow option.
8	Medium	(a)(8) Medication – Allergy List	Consider improving the layout and flow of the allergy screen to reduce steps.
9	High	(a)(14) Implant Device List, UDI Capture	Improve detail findability by defaulting the detail view according to the implant device type.
9	High	(b)(2) Clinical Information Reconciliation	Optimize external reconciliation steps by providing the ability to reconcile or merge multiple outside record items in a batch add or decline process.
11	Medium	(b)(2) Clinical	Consider providing more cues for adding outside record

		Information Reconciliation	items to the chart and disabling the “Complete History” and/or “Save to Chart” buttons until all record items have been added or declined.
<u>11</u>	Low	(b)(2) Clinical Information Reconciliation	Consider a system default association between the current visit and the active, reconciled problems.
<u>13</u>	Low	(b)(2) Clinical Information Reconciliation	Consider providing clearer indications as to which line item orderable pertains to which venue.

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.

- (170.315(a)(5) Patient Demographics)** You will be starting out by opening <Patient Name's> chart. Confirm that you have opened the correct patient. When was the patient admitted?
Optimal Path: Select patient from list > view documents to find most recent intake date
- (170.315(b)(2) Clinical Information Reconciliation: Problems)** Records from the patient's out-of-state PCP have been sent over electronically. Review the new information and add the problems to the patient's record. Indicate whether any may be related to the current complaint and visit.
Optimal Path: Select Outside Documents > Reconcile tab > Select problem > Select add button in detail pane for problem > Select complete reconciliation > Select Problems in Provider View > Select This Visit for problems for the current visit
- (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/Sleeplessness
- (170.315(a)(7) Medication List & (b)(2) Clinical Information Reconciliation: Meds. List)** Perform an Admission Medication Reconciliation and continue all medications except for the following revision: Change the Lasix prescription to 80mg BID.
Optimal Path: Select Medication List > Admission Reconciliation > Select Continue for all medications > Select Lasix > Select 2 tabs dose > Select BID frequency
- (170.315(a)(4) Drug-Drug & Drug-Allergy Checking)** What is this alert informing you of? Keep both the warfarin and the aspirin prescriptions.
Optimal Path: Warning about duplicate/similar drugs > Select override (Physician recommended) > Sign
- (170.315(a)(7) Medication List)** Include in his medication history that he takes Digoxin 250mcg orally daily.
Optimal Path: Select Add Document Med by Hx > Type digoxin in the search > Select digoxin 250 mcg daily order > Select Sign

7. **(170.315(a)(1) CPOE Medications)** You have decided to treat the patient's GERD with Protonix 40mg IV Q12H.
Optimal Path: From the Add Order Search window, search for Protonix 40mg IV > Select medication name > complete frequency (Q12h) details > Select Sign
8. **(170.315(a)(1) CPOE Medications)** You have decided to treat the patient's heart condition with Milrinone 20 mg IV Solution infused over 1 hr.
Optimal Path: From the Add Order Search window, search for Milrinone > Select medication name > complete rate (1 hr) details > Select Sign
9. From the Add Order window, select the patient's CHF problem on the left. What information is shown on the right?
Optimal Path: Select Add + Orders button > Select CHF in Problems panel > Suggested CarePlans are shown on the right
10. **(170.315(a)(3) CPOE Imaging)** You would like to evaluate the patient's condition further. Order the following imaging studies: XR Chest 2 Views and TTE
Optimal Path: Select Add Order > Type Chest XR in the search > Select Chest XR 2 Views > Type TTE in the search > Select CVS ECHO ... (TTE) > In TTE details indicate reason for procedure as SOB or CHF > Under Transport Mode select wheelchair/stretchers/ambulatory > Enter prescribing physician as Reen MD, Rachael > Click Sign
11. **(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 Troponin I/T, Creatinine Kinase – Total and MB (Optional), and Electrocardiogram (EKG) (Optional) > 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 (Stat priority) > Click Sign

Scenario: Heart Mate II LVAD insertion procedure has now been performed and you have finished a post-operative exam of the patient.

12. **(170.315(a)(14) Implant Device List)** Confirm that the procedure was performed by Dr. Xiaodan Fang at Baseline West Medical Center and that the device and procedure information is complete.
Implant description: DEVICE: THORATEC HEARTMATE II, LVAS IMPLANT KIT (WITH SEALED GRAFTS)
Quantity: 1

MR classification: LWQ
UDI: 00813024011170
Manufacturer: Thoratec Corporation
Serial number: 77DEFG45
Model: 104911
Lot number: 128697
Expiration date: 03/06/2019
Comments: No Comment
Procedure: Implantation of LVAD
Implant date: 12/12/2016
Body site: Heart
Implanting facility: Cert Medical Center
Implanted by: Fang, Xiaodan
Optimal Path: Device List > Ensure that the details conform to the information provided
> There are no changes needed

13. Review the labs and vitals following his procedure. Which of the results are abnormal? Are any of the results critically high or low?
Optimal Path: View Vitals component > View Labs component > Point out the (H) or (L) indicators or the colors associated with the results and that a '(C)' indicator and associated color would be used to indicate critically high results > No critical values are present
14. **(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.)
15. **(170.315(a)(1) CPOE Medications, (b)(2) Clinical Information Reconciliation: Medication List & (b)(3) Electronic Prescribing)** Perform a Discharge Medication Reconciliation and continue all medications except for the following revision. Change the frequency of the Percocet 325 mg to every 4 hrs. and increase dose to 2 tabs.
Optimal Path: Select Medication List > Discharge to Home Reconciliation > Select Continue remaining home meds > Select Create New Rx for Percocet documented medication > Select Q4hr frequency > Enter Stop date and time > Select printer WF under send to > Select Sign

16. **(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: Select Medication List > View prescription details > By selecting on the routing information in the medication details while placing the prescription

APPENDIX D: TEST SCRIPT FOR NURSES

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.

- (170.315(a)(5) Patient Demographics)** You will be starting out by opening <Patient Name's> chart. In conducting your admissions interview/assessment, you've discovered some gaps in the patient's information. Add that his Ethnicity is Hispanic and his preferred language is Spanish.
Optimal Path: Select patient from list > Confirm correct patient > Select AddHoc button charting on toolbar > Select Admission History Adult > Select Chart > Check Spanish under primary language > Select Sign Form
- (170.315(a)(8) Med-Allergy List)** The patient informs you that the "Sulfa"-meth-oxazole allergy is not correct. He gets diarrhea when taking sulfa drugs. Update his allergy.
Optimal Path: Select Ambulatory Workflow tab > Select "Sulfamethoxazole" allergy > Select Modify > Enter Diarrhea for reaction > Select the diarrhea from the list that has the terminology of "Snomed" > Remove Nausea > Select Save
- (170.315 (b)(2) Clinical Information Reconciliation: Allergies)** Your unit clerk has informed you that the patient's records have been imported from his primary care physician and are available for review. Reconcile the allergies from his out-of-state PCP with those already in the allergy list.
Optimal Path: Select Outside Documents > Reconcile tab > Select allergy > Select add button in detail pane for shell fish allergy > Select complete reconciliation
- (170.315(b)(2) Clinical Information Reconciliation: Problems)** Update the patient's problem list from the electronic records sent from the out-of-state PCP.
Optimal Path: Select Outside Documents > Reconcile tab > Select problem > Select add button in detail pane for problem > Select complete reconciliation
- (170.315(a)(7) Medication List)** Review the patient's home medications and document that he is also taking the following medication: Digoxin 125 mcg 1 tab(s) orally once a day.
Optimal Path: From the Add Order Search window, search for Digoxin 125 mcg > Select medication name > Complete dose (125 mcg) details > Select document Hx

6. **(170.315(a)(7) Medication List)** He also tells you that the dose for hypothyroidism medication has been increased. Update the Levothyroxine home medication from 25mcg to 50mcg once a day.
Optimal Path: Right-click on Levothyroxine > Select Cancel/Discontinue > Select Reason > Select Add > Select document by history > Type Levothyroxine > Select Levothyroxine 0.25 mg daily order > Select Document Hx

7. **(170.315(a)(4) Drug-Allergy Checking & 170.315(a)(8) Med-Allergy List)** The patient's spouse has arrived and informed you that he also has an allergy to Hydrocodone in which he has hives. Add the new Allergy to the list.
Optimal Path: Select Ambulatory Workflow tab > Enter Hydrocodone in search field > Select Hydrocodone from list options > Enter Hives in reaction field > Select hives reaction from option list > Select Severity > Select Allergy reaction type > Select Drug under category > Select Save > Indicate allergy produced a reverse allergy checking alert

Scenario: The patient's surgical procedure for a Heart Mate II LVAD insertion went successfully and you are finishing up your post-operative assessment.

8. Review vitals following his procedure. Which of the results are abnormal? Are any of the results critically high or low?
Optimal Path: View Vitals component > View Labs component > Point out the (H) or (L) indicators or the colors associated with the results and that a '(C)' indicator and associated color would be used to indicate critically high results > No critical values are present

9. **(170.315(a)(14) Implant Device List)** Confirm that the procedure was performed by <Physician Name> at <Location Name>. Modify the implant history with correct information as needed from the following device details:
 Implant description: DEVICE: THORATEC HEARTMATE II, LVAS IMPLANT KIT (WITH SEALED GRAFTS)
 Quantity: 1
 MR classification: LWQ
 UDI: 00813024011170
 Manufacturer: Thoratec Corporation
 Serial number: 77DEFG45
 Model: 104911
 Lot number: 128697
 Expiration date: 03/06/2019
 Comments: No Comment
 Procedure: Implantation of LVAD
 Implant date: 12/12/2016

Body site: Heart

Implanting facility: Cert Medical Center

Implanted by: TBD

Optimal Path: Select Histories > Implant tab > Select device > Enter Thoratec Company under manufacturer > Select OK

10. The patient is asking a lot of questions about the procedure and you decide to provide further patient education about post-surgical care. Review the additional information to be provided to the patient.

Optimal Path: Select Discharge Workflow > Select Patient Education component > Enter Post-surgical in search field > Select Postsurgical Checklist (or other similar education related to the heart condition)