IHS RESOURCE AND PATIENT MANAGEMENT SYSTEM

SUMMATIVE USABILITY TESTING FINAL REPORT

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Group B: 7/21/2020-8/3/2020
Group C: 8/3/2020-8/7/2020

System Test Laboratory:
Contact Person: Shannon Hurley, Information Architect/Usability Engineer, IHS Contractor
Phone Number: 505-379-2893
Email Address: Shannon.Hurley@IHS.gov
Mailing Address: 5600 Fishers Lane, Rockville, MD 20857

Version History

Date	Version	Revised By:	Revision/Change Description
8/7/2020	1.0	Jason Nakai	Initial Draft
8/20/2020	2.0	Jason Nakai	Updated
8/12/2022	2.1	Shannon Hurley	Updated date to reflect review of (b)(2) criteria for 2015 Edition Cures Update; no updates or changes to the criteria were made.

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1.0 Executive Summary

Summative usability testing (hereinafter referred to as “usability testing”) of the Resource and Patient Management System (RPMS) Electronic Heath Record (EHR) application was conducted during 2019 - 2020 as part of the 2015 Certified Health IT (g)(3) Safety-Enhanced Design criterion. The purpose of this test was to evaluate and validate the usability of the current user interface, and provide evidence of user-centered design (UCD) practices in the application.

During the usability test, healthcare providers and other users matching the target demographic criteria participated in summative usability testing for each safety-enhanced design criterion and the associated capabilities.

This study collected performance data on the top tasks as identified by the owners of the criteria to be tested.

The criteria included in this test report are:

- 170.315(a)(1) Computerized provider order entry—medications
- 170.315(a)(2) Computerized provider order entry—laboratory
- 170.315(a)(3) Computerized provider order entry—diagnostic imaging
- 170.315(a)(4) Drug-drug, drug-allergy interaction checks
- 170.315(a)(5) Demographics
- 170.315(a)(9) Clinical decision support
- 170.315(a)(14) Implantable Device List (IDL)
- 170.315(b)(2) Clinical Information Reconciliation and Incorporation (CIR)

These criteria were broken down into 3 test groups (A, B, and C).

During the approximately 60-minute one-on-one usability test sessions, each participant was greeted by the administrator who introduced the test. Participants were asked to share their prior EHR experience.

During each test session, the administrator timed the test and recorded user performance data. Participant screens and audio were also recorded for subsequent analysis.

The following types of data were collected for each participant:

- Demographic data
- Number of tasks successfully completed
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system

All participant data was de-identified so that no correspondence could be made from the identity of the participant to the data collected.

The test method and metrics were based on the National Institute of Standards and Technology (NIST) Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741). Modifications were made where necessary to better evaluate the application against the contract goals and requirements. Following the conclusion of the test, participants were asked to complete a post-test questionnaire and were thanked for their participation.

The Task Satisfaction Rating is based on the following pre-defined scale:

- 1 (Very Difficult) – 5 (Very Easy).

1.1 Major Findings

Based on the score of the Task Satisfaction Rating, the participants found the EHR easy to use. Participants did state that the initial learning curve is steep and training is necessary. However, once they learned to use the application, participants completed tasks with great efficiency and effectiveness.

Criteria	Task Success Rate Mean %	Task Satisfaction Rating (Scale 1-5) 1(Very Difficult)-5(Very Easy)
170.315(a)(1) Computerized provider order entry—medications	100%	4.67
170.315(a)(2) Computerized provider order entry—laboratory	100%	4.83
170.315(a)(3) Computerized provider order entry—diagnostic imaging	92%	4.67
170.315(a)(4) Drug-drug, drug-allergy interaction checks	100%	4.67
170.315(a)(5) Demographics	100%	4.91
170.315(a)(9) Clinical decision support	100%	5
170.315(a)(14) Implantable Device List (IDL)	88%	4.21
170.315(b)(2) Clinical Information Reconciliation and Incorporation (CIR)	98%	4.68

Table 1: Criteria Success and Satisfaction Rating Summary

1.2 Recommendations

Group A

Criteria/Module	Findings
(a)(1) CPOE – medications	Clinical Indication box under Medication Order -- if a provider has not already added a diagnosis to the problem list and they search for it here, it does not also save to the problem list; this causes some providers frustration. Participants did not like that if POV is not added for acute visit, they have to go to dropdown menu and select what the medicine is treating.
(a)(2) CPOE – laboratory	'Order a Lab Test' screen – when a provider is searching a 'clinical indication' but has not added it to the problem list, there is no additional option to add it to the problem list from this screen.
(a)(3) CPOE – diagnostic imaging	Fix tab order of form fields. Improve form field labeling.
(a)(4) Drug-drug, drug-allergy interaction checks for CPOE	Would like to see a hard stop for alerts, something interactive that providers would have to read and acknowledge they have done before continuing. Better configuration for alerts to reduce alert fatigue.
(a)(9) Clinical decision support	Better training available on demand. Better documentation and training on troubleshooting procedures. Nurses have commented that they would like the capability to complete the note/dialogue associated with the reminder from the "Available Reminders" pop up box. Needs to be more flexible of configurable. Ability to set reminders as "Do not remind" or "No longer relevant".

Table 2: Areas for Improvement – Group A

Group B

Criteria/Module	Findings
(a)(5) Demographics	Fix consistency of design and functionality for form input fields. Not all drop-down menus look or function the same. Error messaging is too far from the input field. First "Remove" link for Ethnicity and Race is disabled but should be removed. Better instructions for form inputs. SO/GI checkbox groups should instruct user if it is single or multi-select.

Table 3: Areas for Improvement – Group B

Group C

Criteria/Module	Findings
(a)(14) Implantable device list	Make form inputs more consistent with similar inputs in the EHR or with industry standards. Most participants had trouble with the Imprecise Date Picker. Any form input that required the use of a dialog or widget was troublesome. For Imprecise Date Picker, participants wanted to type directly into the input without having to launch the date picker. Layout of the Add Implant Event form was confusing. Form labels were underneath the inputs which is not consistent with other forms in the EHR. Drop-down Menus do not have a function to clear the selection. Placement of tooltips hid menu options. Improve navigation of the CCDA review view. When user checks or unchecks a section, they are taken to the top of the CCDA preview.
(b)(2) Clinical information reconciliation and incorporation	Form inputs are not consistent in labeling or functionality. Liked the addition of a "reviewed" indicator and a Set All Reviewed button. Much faster and more usable than before. It was unusable before the updates. Looking forward to using. CCDA document can be too long and tricky to navigate

Table 4: Areas for Improvement – Group C

2.0 Introduction

The Office of the National Coordinator for Health Information Technology (ONC) Health IT Certification Program is a voluntary certification program established by the Office of the National Coordinator for Health IT to provide for the certification of health IT.

The Indian Health Service (IHS) Office of Information Technology (OIT) has requested that the Resource and Patient Management System Electronic Health Record (RPMS EHR) achieve ONC 2015 Health IT Certification. As part of the certification criteria, (g)(3) Safety-Enhanced Design requires that summative usability testing be performed on specific criteria and the test data be provided as part of a final test report. The test report will follow the National Institute of Standards and Technology (NIST) Customized Common Industry Format Template for Electronic Health Record Usability Testing (NISTIR 7742).

Summative usability testing is a task-based evaluation that measures the ease of use of a completed product. The results are analyzed and compared to the usability requirements to determine if those requirements have been met. Summative usability testing was conducted on RPMS Suite (BCER) v4.0. The intended users for this software include medical providers, nursing staff, health information management staff, pharmacy staff, and imaging and laboratory personnel at clinics and hospitals.

2.1 Purpose

The purpose of this test was to evaluate and validate each safety-enhanced design criterion and the associated capabilities. The test ensures that the completed product meets the 2015 CHIT certification requirements concerning user-centered design.

2.2 Scope

The scope of usability testing is limited to testing user-involved tasks. Automated tasks or tasks without user interaction are not covered in this test. Functional testing is not covered in detail. Functionality is only tested as it pertains to the usability of the product or feature being tested.

The test was limited in scope to the following criteria:

- 170.315(a)(1) Computerized provider order entry—medications
- 170.315(a)(2) Computerized provider order entry—laboratory
- 170.315(a)(3) Computerized provider order entry—diagnostic imaging
- 170.315(a)(4) Drug-drug, drug-allergy interaction checks

- 170.315 (a)(5) Demographics
- 170.315(a)(9) Clinical decision support
- 170.315(a)(14) Implantable Device List (IDL)
- 170.315(b)(2) Clinical Information Reconciliation and Incorporation (CIR)

3.0 Method

See Appendix A for Participant and Test data.

The test method and metrics were based on the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741). Modifications were made where necessary to better evaluate the application against the contract goals and requirements.

The objective of this test was to uncover areas where the application performed well and areas where the application failed to meet the usability needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same EHR capability and/or comparison with other EHR capabilities provided the same tasks are used. This testing serves as both a means to record or benchmark current usability and to identify areas where improvements must be made.

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

- Number of tasks successfully completed
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system (Task Satisfaction Rating)
    - 1 (Very Difficult) – 5 (Very Easy)

Testing for the criteria was broken down into 3 separate test groups as follows:

1. Test Group A – Existing Functionality
    - 170.315(a)(1) Computerized provider order entry—medications
    - 170.315(a)(2) Computerized provider order entry—laboratory
    - 170.315(a)(3) Computerized provider order entry—diagnostic imaging
    - 170.315(a)(4) Drug-drug, drug-allergy interaction checks

- 170.315(a)(9) Clinical decision support

2. Test Group B – New Functionality
    - 170.315(a)(5) Demographics
3. Test Group C – New Functionality
    - 170.315(a)(14) Implantable Device List (IDL)
    - 170.315(b)(2) Clinical Information Reconciliation and Incorporation (CIR)

3.1 Roles and Responsibilities

Role/Function	Responsibilities
Project Manager/Criteria Owner	Responsible for the management, monitoring and tracking of the project and oversees all areas.
Usability Test Lead / Test Administrator	• Ensures that usability testing is conducted successfully and meets all usability testing deadlines. • Provides application systems analysis for application testing activities. • Prepares required documentation at the program level for testing activities. • Monitors and escalates risks or concerns about achieving goals or meeting schedules to program leadership. • Prepares all testing instructions, scripts and materials for use in the testing session. • Performs analysis of testing results, prepares and delivers test report. • Moderates the test • Collects test data

Role/Function	Responsibilities
Test Observers	• Provide any needed training or support • Monitor the testing session
Test Participants	• Complete the assigned tasks • Provide honest feedback on their experience

Table 5: Roles and Responsibilities

3.1.1 Test Participants

The total number of test participants per round of testing is listed below:

1. Test Group A – (a)(1)-(4) & (a)(9)
    - 12 Test Participants
2. Test Group B – (a)(5)
    - 11 Test Participants
3. Test Group C – (a)(14) & (b)(2)
    - 11 Test Participants

Participants in the test were:

- typical end-users such as physicians and medical providers
- trained to use the application prior to usability testing
- recruited by the 2015 CHIT project team and IHS criteria owners
- not compensated for participation
- had no direct connection to the development of the application
- given the same orientation and level of training as the actual end users
- assigned a participant ID initially based on scheduling order

Once participants were identified, they were scheduled for 60-minute one-on-one web conferencing (Skype, Adobe Connect) sessions. A calendar was used to keep track of the participants' schedule and a spreadsheet tracked participants' location (site) and contact information.

3.2 Test Location

The test was conducted remotely via the use of video conferencing and desktop sharing software (Microsoft Skype for Business, Adobe Connect).

3.3 Test Environment

The test participants were:

- physically located at their normal duty stations;
- logged into the RPMS EHR platform connected to a test database;
- utilizing their assigned workstation computers with a Windows operating system, a modern computer screen, a minimum screen resolution of 1024x768, and default color settings;
- interacting with the application with a mouse and keyboard; and
- connected to the video conferencing software via a Wide Area Network (WAN).

The test administrator and observers were also physically distributed and connected via video conferencing software.

For Test Group A, the test participants shared their screens and were the only desktops visible during testing. For Test Groups B and C, the test administrator shared his screen and participants were given control of the test application through the test administrator's screen.

In the case of Test Group B and C, the technical system performance (i.e., response time) was not representative to what actual users would experience in a field implementation, as they were working through the test administrator's workstation and not their own.

3.4 Test Tools

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

1. Demographic Questionnaire
2. Moderator's Guide
3. Post-test Questionnaire

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

Video conferencing software (MS Skype, Adobe Connect) was used to connect participants, the administrator and observers. This software was also used to record the video and audio of test sessions.

3.5 Tasks

The testing scenarios and tasks were constructed to be realistic and representative of the kinds of activities a user would perform using the capabilities being tested. Tasks were chosen with the test objectives in mind to ensure that participants provided the most meaningful data possible. The tasks were arranged to simulate a normal patient visit.

The following is the order in which the tasks were administered:

- 170.315(a)(9) Clinical decision support
    1. Access Clinical Reminders List.
    2. Select a reminder and view details.
    3. Resolve the reminder.
    4. Refresh the Clinical Reminders list and confirm that the reminder has been resolved.

- 170.315(a)(1) Computerized provider order entry—medications, 170.315(a)(4) Drug-drug, drug-allergy interaction checks
    1. Access the patient's Orders List.
    2. Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test.)
    3. Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert.)
    4. Change the Penicillin order to Erythromycin. (Test trigger for drug-drug interaction alert.)
    5. Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert.)

- 170.315(a)(2) Computerized provider order entry—laboratory
    1. Access the patient's Orders List.
    2. Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.
    3. Change the collection date of the HgbA1c order. Accept and sign the order.

- 170.315(a)(3) Computerized provider order entry—diagnostic imaging
    1. Access patient's Orders List.
    2. Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.
    3. Change the Transport method to Stretcher. Accept and sign the order.

- 170.315(a)(5) Demographics
    1. Register New Patient
    2. Add Preferred Language to Existing Patient
    3. Edit Patient Information
    4. Add SO/GI Information

5. Edit SO/GI Information
6. Update Preliminary Cause of Death

- 170.315(a)(14) Implantable Device List
  1. Add New Implantable Device
  2. Access and change UDI and Status
  3. Preview a list that contains UDIs, description, and method to access UDIs

- 170.315(b)(2) Clinical Information Reconciliation and Incorporation
  1. Reconcile CCDA Problems
  2. Reconcile CCDA Adverse Reactions
  3. Reconcile CCDA Medications
  4. Preview new CCDA with reconciled data

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

3.6 Procedure

Upon arrival, each participant was greeted by the administrator and matched to a name on the participant schedule. The participant was then assigned a participant ID.

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

Each participant was instructed to perform the tasks:

- As quickly as possible making as few errors and deviations as possible.

- Without assistance; administrators were allowed to give immaterial guidance and clarification on tasks, but not instructions on use.

Testing for the criteria was broken down into 3 separate test groups as follows:

1. Test Group A – Existing Functionality (a)(1)-(4); (a)(9)

2. Test Group B – New Functionality – (a)(5) Demographics

3. Test Group C – New Functionality – (a)(14) Implantable Device List (IDL) and (b)(2) Clinical Information Reconciliation and Incorporation (CIR)

Each participant per Test Group used the same application version and was provided with the same set of instructions.

For Test Group A, the administrator instructed participants to log into the application as specific user types. For Test Groups B and C, the administrator logged into the test environment and then instructed the user to request control. After log in, the user was instructed to complete a series of tasks (given one at a time) using the application.

Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated that the task was successfully completed.

Scoring is discussed in Section 3.7 Usability Metrics.

After completion of the testing tasks, the administrator gave the participant a post-test questionnaire (System Usability Scale), asked if they had any questions, and thanked them for their participation.

Each participant's demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire ratings were recorded into the participant spreadsheet.

Following each test session, the video recordings were reviewed and checked against the data logged in the participant spreadsheet. The participant spreadsheet was updated with any edits or additional information such as verbalizations.

3.7 Usability Metrics

According to the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records, EHRs should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction. To this end, metrics for effectiveness, efficiency and user satisfaction were captured during the usability testing.

The goals of the test were to assess:

1. Effectiveness by measuring participant success rates and errors
2. Efficiency by measuring the average task time and path deviations
3. Satisfaction by measuring task satisfaction ratings and SUS scores

3.7.1 Data Scoring

The following table (Table 6) details how tasks were scored, errors evaluated, and the time data analyzed.

Measures	Rationale and Scoring
Effectiveness: Task Success	A task was counted as a "Success" if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis. The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage. Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency. Optimal task performance time, as benchmarked by expert performance under realistic conditions, is recorded when constructing tasks. Target task times used for task times in the Moderator's Guide must be operationally defined by taking multiple measures of optimal performance and multiplying by some factor [e.g., 1.25] that allows some time buffer because the participants are presumably not trained to expert performance. Thus, if expert, optimal performance on a task was [x] seconds then allotted task time performance was [x * 1.25] seconds. This ratio should be aggregated across tasks and reported with mean and variance scores.
Effectiveness: Task Failures	If the participant abandoned the task, did not reach the correct answer or performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as a "Failures." No task times were taken for errors. The total number of errors was calculated for each task and then divided by the total number of times that task was attempted. Not all deviations would be counted as errors.[11] This should also be expressed as the mean number of failed tasks per participant. On a qualitative level, an enumeration of errors and error types should be collected.
Efficiency: Task Deviations	The participant's path (i.e., steps) through the application was recorded. Deviations occur if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation.

Measures	Rationale and Scoring
Satisfaction: **Task Satisfaction Rating**	Participant's subjective impression of the ease of use of the application was measured by administering both a simple post-task question as well as a post-session questionnaire. After each task, the participant was asked to rate "Overall, this task was:" on a scale of 1 (Very Difficult) to 5 (Very Easy). These data are averaged across participants. Common convention is that average ratings for systems judged easy to use should be 3.3 or above. To measure participants' confidence in and likeability of the system overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. Questions included, "I think I would like to use this system frequently," "I thought the system was easy to use," and "I would imagine that most people would learn to use this system very quickly."

Table 6: Measure Scoring

4.0 Results

4.1 Data Analysis and Reporting

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above.

Participants who failed to follow session and task instructions had their data excluded from the analyses.

4.2 Discussion of Findings

Based on the score of the Task Satisfaction Rating, the participants found the EHR easy to use. Participants did state that the initial learning curve is steep and training is necessary. However, once they learned to use the application, participants completed tasks with great efficiency and effectiveness.

The path taken to complete the tasks differed from participant to participant. This was influenced by the differing configuration of the test sites' EHR UIs. In spite of the varied paths to complete tasks, time per task was minimal and consistent, and errors were virtually non-existent.

All test participants felt the components were consistent and functioned as expected. The majority found the RPMS EHR to be an effective tool for completing their work tasks. Most said they would recommend this EHR to their colleagues.

The top issues the test participants remarked on were:

- Training
    - More training is needed.
    - Better training is needed.
    - Training should be updated and offered on a more consistent basis.
- UI Configuration
    - All felt the ability to customize the EHR UI to be a strength and that many issues they had with the system could be resolved with configuration updates.
    - Participants wanted more input on how the EHR UI is configured. Users felt locked into their current EHR configuration.

  - While some liked the many ways to complete a given task and others did not, most agreed that it was unnecessarily redundant and added to confusion.

- Form Instructions and Elements
  - All participants liked the overall consistency of the EHR UI.
  - Better guidance on required fields in the ordering process.
  - Interface and interface elements are cramped, especially if the view port cannot be resized.
  - The default sizing of many windows, panels and lists does not allow the information they contain to be seen. This renders them useless until being resized, which leads to repeatedly having to adjust displays in order to use them.
  - Windows, panels and lists were inconsistent in their ability to be resized. Participants felt that all displays should allow resizing and should retain any adjustments made to them.

4.2.1 Effectiveness

4.2.1.1 Group A

- 170.315 (a)(1) Computerized provider order entry—medications
- 170.315 (a)(2) Computerized provider order entry—laboratory
- 170.315 (a)(3) Computerized provider order entry—diagnostic imaging
- 170.315 (a)(4) Drug-drug, drug-allergy interaction checks
- 170.315 (a)(9) Clinical decision support

#	Tasks - Group A	# Participants	Task Success Rate - Mean %	Task Success Rate - Std Dev %	Task Errors Mean %	Task Errors Std Dev %
	170.315(a)(9) Clinical decision support					
1	Access Clinical Reminders List.	12	100%	0%	0%	0%
2	Select a reminder and view details.	12	100%	0%	0%	0%
3	Resolve the reminder.	12	100%	0%	0%	0%
4	Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	12	100%	0%	0%	0%
	170.315(a)(1) Computerized provider order entry—medications & 170.315(a)(4) Drug-drug, drug-allergy interaction checks					
5	Access the patient's Orders List.	12	100%	0%	0%	0%
6	Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	12	100%	0%	0%	0%
7	Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	12	100%	0%	0%	0%
8	Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	12	100%	0%	0%	0%
9	Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	12	100%	0%	0%	0%
	170.315(a)(2) Computerized provider order entry—laboratory					
10	Access the patient's Orders List.	12	100%	0%	0%	0%
11	Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	12	100%	0%	0%	0%
12	Change the collection date of the HgbA1c order. Accept and sign the order.	12	100%	0%	0%	0%
	170.315(a)(3) Computerized provider order entry—diagnostic imaging					
13	Access patient's Orders List.	12	92%	29%	0%	0%
14	Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	12	92%	29%	0%	0%
15	Change the Transport method to Stretcher. Accept and sign the order.	12	92%	29%	0%	0%

Table 7: Effectiveness – Group A

4.2.1.2 Group B

- 170.315(a)(5) Demographics

#	Tasks - Group B	# Participants	Task Success Rate - Mean %	Task Success Rate - Std Dev %	Task Errors Mean %	Task Errors Std Dev %
	170.315(a)(5) Demographics					
1	Register New Patient	11	100%	0%	0%	0%
2	Add Preferred Language to Existing Patient	11	100%	0%	0%	0%
3	Edit Patient Information	11	100%	0%	9%	30%
4	Add SO/GI Information	11	100%	0%	0%	0%
5	Edit SO/GI Information	11	100%	0%	0%	0%
6	Update Preliminary Cause of Death	11	100%	0%	0%	0%

Table 8: Effectiveness – Group B

4.2.1.3 Group C

- 170.315(a)(14) Implantable Device List (IDL)
- 170.315(b)(2) Clinical Information Reconciliation and Incorporation (CIR)

#	Tasks - Group C	# Participants	Task Success Rate - Mean %	Task Success Rate - Std Dev %	Task Errors Mean %	Task Errors Std Dev %
	170.315(a)(14) IDL					
1	Add New Implantable Device	11	91%	30%	0%	0%
2	Access and change UDI and Status	11	82%	40%	0%	0%
3	Preview a list that contains UDIs, description and method to access UDIs	11	91%	30%	0%	0%
	170.315(b)(2) CIR					
4	Reconcile CCDA Problems	11	100%	0%	9%	30%
5	Reconcile CCDA Adverse Reactions	11	100%	0%	9%	30%
6	Reconcile CCDA Medications	11	100%	0%	0%	0%
7	Preview new CCDA with reconciled data	11	91%	30%	0%	0%

Table 9: Effectiveness – Group C

4.2.2 Efficiency

4.2.2.1 Group A

#	Tasks - Group A	Observed # Steps	Optimal # Steps	Task Time Observed Mean (seconds)	Task Time Std Dev (seconds)	Task Time Optimal (seconds)
	170.315(a)(9) Clinical decision support					
1	Access Clinical Reminders List.	2	2	7	4	13
2	Select a reminder and view details.	3	3	12	4	20
3	Resolve the reminder.	4	4	46	21	83
4	Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	2	2	7	5	15
	170.315(a)(1) Computerized provider order entry—medications & 170.315(a)(4) Drug-drug, drug-allergy interaction checks					
5	Access the patient's Orders List.	2	2	5	1	7
6	Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	12	12	71	31	127
7	Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	14	14	45	6	63
8	Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	14	14	55	10	81
9	Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	5	5	35	11	57
	170.315(a)(2) Computerized provider order entry—laboratory					
10	Access the patient's Orders List.	2	2	4	2	7
11	Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	6	6	47	8	68
12	Change the collection date of the HgbA1c order. Accept and sign the order.	5	5	38	7	56

#	Tasks - Group A	Observed # Steps	Optimal # Steps	Task Time Observed Mean (seconds)	Task Time Std Dev (seconds)	Task Time Optimal (seconds)
	170.315(a)(3) Computerized provider order entry—diagnostic imaging					
13	Access patient's Orders List.	2	2	4	3	8
14	Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	6	6	50	24	92
15	Change the Transport method to Stretcher. Accept and sign the order.	5	5	20	7	33

Table 10: Efficiency – Group A

4.2.2.2 Group B

#	Tasks - Group B	Observed # Steps	Optimal # Steps	Task Time Observed Mean (seconds)	Task Time Std Dev (seconds)	Task Time Optimal (seconds)
	170.315(a)(5) Demographics					
1	Register New Patient	16	15	282	105	483
2	Add Preferred Language to Existing Patient	11	10	73	29	127
3	Edit Patient Information	8	7	83	38	151
4	Add SO/GI Information	8	7	57	34	113
5	Edit SO/GI Information	7	7	50	18	85
6	Update Preliminary Cause of Death	13	12	74	29	128

Table 11: Efficiency – Group B

4.2.2.3 Group C

#	Tasks - Group C	Observed # Steps	Optimal # Steps	Task Time Observed Mean (seconds)	Task Time Std Dev (seconds)	Task Time Optimal (seconds)
	170.315(a)(14) IDL					
1	Add New Implantable Device	0.35	261	255	135	487
2	Access and change UDI and Status	0	61	61	55	145
3	Preview a list that contains UDIs, description and method to access UDIs	0	40	41	28	86
	170.315(b)(2) CIR					
4	Reconcile CCDA Problems	0.2	120	139	87	282
5	Reconcile CCDA Adverse Reactions	0.7	142	158	93	313
6	Reconcile CCDA Medications	0.35	122	129	55	230
7	Preview new CCDA with reconciled data	0.15	116	115	74	236

Table 12: Efficiency – Group C

4.2.3 Satisfaction

4.2.3.1 Group A

#	Tasks - Group A	# Participants	Task Rating Likert Scale	Task Rating Mean	Task Rating Std Dev
	170.315(a)(9) Clinical decision support				
1	Access Clinical Reminders List.	12	1-5	5	0
2	Select a reminder and view details.	12	1-5	5	0
3	Resolve the reminder.	12	1-5	5	0
4	Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	12	1-5	5	0
	170.315(a)(1) Computerized provider order entry—medications & 170.315(a)(4) Drug-drug, drug-allergy interaction checks				
5	Access the patient's Orders List.	12	1-5	4.67	0.78
6	Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	12	1-5	4.67	0.78
7	Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	12	1-5	4.67	0.78
8	Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	12	1-5	4.67	0.78
9	Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	12	1-5	4.67	0.78
	170.315(a)(2) Computerized provider order entry—laboratory				
10	Access the patient's Orders List.	12	1-5	4.83	0.58
11	Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	12	1-5	4.83	0.58
12	Change the collection date of the HgbA1c order. Accept and sign the order.	12	1-5	4.83	0.58
	170.315(a)(3) Computerized provider order entry—diagnostic imaging				
13	Access patient's Orders List.	12	1-5	4.67	1.15
14	Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	12	1-5	4.67	1.15
15	Change the Transport method to Stretcher. Accept and sign the order.	12	1-5	4.67	1.15

Table 13: Satisfaction – Group A

4.2.3.2 Group B

#	Tasks - Group B	# Participants	Task Rating Likert Scale	Task Rating Mean	Task Rating Std Dev
	170.315(a)(5) Demographics				
1	Register New Patient	11	1-5	4.82	0.60
2	Add Preferred Language to Existing Patient	11	1-5	4.82	0.60
3	Edit Patient Information	11	1-5	4.82	0.60
4	Add SO/GI Information	11	1-5	5.00	0.00
5	Edit SO/GI Information	11	1-5	5.00	0.00
6	Update Preliminary Cause of Death	11	1-5	5.00	0.00

Table 14: Satisfaction – Group B

4.2.3.3 Group C

#	Tasks - Group C	# Participants	Task Rating Likert Scale	Task Rating Mean	Task Rating Std Dev
	170.315(a)(14) IDL				
1	Add New Implantable Device	11	1-5	4.09	1.38
2	Access and change UDI and Status	11	1-5	3.91	1.64
3	Preview a list that contains UDIs, description and method to access UDIs	11	1-5	4.64	1.21
	170.315(b)(2) CIR				
4	Reconcile CCDA Problems	11	1-5	4.82	0.6
5	Reconcile CCDA Adverse Reactions	11	1-5	4.45	0.93
6	Reconcile CCDA Medications	11	1-5	4.82	0.6
7	Preview new CCDA with reconciled data	11	1-5	4.64	1.21

Table 15: Satisfaction – Group C

4.2.3.4 System Usability Scale (SUS)

The results from the System Usability Scale (SUS) from the post-test questionnaire, scored the subjective satisfaction with the system based on performance with the listed testing tasks by group.

System Usability Scale (SUS) Score	Score
Group A (a)(1)-(4); (a)(9)	73.13
Group B (a)(5)	90.68
Group C (a)(14) & (b)(2)	87.05

Table 16: SUS Scores

According to usability.gov, "[b]ased on research, a SUS score above a 68 would be considered above average and anything below 68 is below average".

4.2.4 Major Findings

4.2.4.1 Group A

Criteria/Module	Findings
(a)(1) CPOE – medications	All liked the Quick Order menus. Very valuable tool.
(a)(2) CPOE – laboratory	Easy to use. Consistent workflow.
(a)(3) CPOE – diagnostic imaging	Easy to use. Does not follow a logical tab order.
(a)(4) Drug-drug, drug-allergy interaction checks for CPOE	Some found the alerts to be too frequent and of little use. They can be bypassed and ignored. Alert fatigue causes some to turn it off completely.
(a)(9) Clinical decision support	Useful. Not flexible enough to be used beyond a limited set of functionalities. Needs more customization options. Great when it works but difficult to troubleshoot.

Table 17: Major Findings – Group A

4.2.4.2 Group B

Criteria/Module	Findings
(a)(5) Demographics	Participants liked that more than 1 ethnicity and race could be selected, as well as how many more options are available for ethnicity and race. Participants did not like the inconsistency of the form inputs. Overall, test participants found the criteria capabilities usable.

Table 18: Major Findings – Group B

4.2.4.3 Group C

Criteria/Module	Findings
(a)(14) Implantable device list	Nearly all test participants were new to this functionality. Even without experience, participants were able to successfully complete complex tasks. Usability can be improved. Form inputs are not consistent with similar inputs in the EHR or with industry standards. Most participants had trouble with the Imprecise Date Picker.
(b)(2) Clinical information reconciliation and incorporation	Form inputs are not consistent in labeling or functionality. Liked the addition of a "reviewed" indicator and a Set All Reviewed button. Much faster and more usable than before. It was unusable before the updates. Looking forward to using. CCDA document can be too long and tricky to navigate.

Table 19: Major Findings – Group C

4.2.5 Areas for Improvement

4.2.5.1 Group A

Criteria/Module	Findings
(a)(1) CPOE – medications	Clinical Indication box under Medication Order -- if a provider has not already added a diagnosis to the problem list and they search for it here, it does not also save to the problem list; this causes some providers frustration. Participants did not like that if POV is not added for acute visit, they have to go to dropdown menu and select what the medicine is treating.
(a)(2) CPOE – laboratory	'Order a Lab Test' screen – when a provider is searching a 'clinical indication' but has not added it to the problem list, there is no additional option to add it to the problem list from this screen.
(a)(3) CPOE – diagnostic imaging	Fix tab order of form fields. Improve form field labeling.
(a)(4) Drug-drug, drug-allergy interaction checks for CPOE	Would like to see a hard stop for alerts, something interactive that providers would have to read and acknowledge they have done before continuing. Better configuration for alerts to reduce alert fatigue.
(a)(9) Clinical decision support	Better training available on demand. Better documentation and training on troubleshooting procedures. Nurses have commented that they would like the capability to complete the note/dialogue associated with the reminder from the "Available Reminders" pop up box. Needs to be more flexible of configurable. Ability to set reminders as "Do not remind" or "No longer relevant".

Table 20: Areas for Improvement – Group A

4.2.5.2 Group B

Criteria/Module	Findings
(a)(5) Demographics	Fix consistency of design and functionality for form input fields. Not all drop-down menus look or function the same. Error messaging is too far from the input field. First "Remove" link for Ethnicity and Race is disabled but should be removed. Better instructions for form inputs. SO/GI checkbox groups should instruct user if it is single or multi-select.

Table 21: Areas for Improvement – Group B

4.2.5.3 Group C

Criteria/Module	Findings
(a)(14) Implantable device list	Make form inputs more consistent with similar inputs in the EHR or with industry standards. Most participants had trouble with the Imprecise Date Picker. Any form input that required the use of a dialog or widget was troublesome. For Imprecise Date Picker, participants wanted to type directly into the input without having to launch the date picker. Layout of the Add Implant Event form was confusing. Form labels were underneath the inputs which is not consistent with other forms in the EHR. Drop-down Menus do not have a function to clear the selection. Placement of tooltips hid menu options. Improve navigation of the CCDA review view. When user checks or unchecks a section, they are taken to the top of the CCDA preview.
(b)(2) Clinical information reconciliation and incorporation	Form inputs are not consistent in labeling or functionality. Liked the addition of a "reviewed" indicator and a Set All Reviewed button. Much faster and more usable than before. It was unusable before the updates. Looking forward to using. CCDA document can be too long and tricky to navigate

Table 22: Areas for Improvement – Group C

5.0 Acronym List

Acronym	Description
EHR	Electronic Health Record
CHIT	Certified Health Information Technology
UI	User Interface
IHS	Indian Health Service
ISO	International Organization for Standardization
NIST	National Institute of Standards and Technology
OIT	Office of Information Technology
RPMS	Resource and Patient Management System
SESS	Software Engineering Support Services

Table 23: Acronyms

6.0 Appendix A: Participant and Test Result Data

Participant Identifier	Participant Gender	Participant Age	Participant Education	Participant Occupation/Role	Participant Professional Experience (months)	Participant Computer Experience (months)	Participant Product Experience (months)	Participant Assistive Technology Needs
Group A - 14	Female	30-39	Doctorate degree	General Pediatrician	24	25	24	No
Group A - 1	Female	40-49	Master's degree	Registered Nurse/Case Manager	168	60	96	No
Group A - 12	Female	30-39	Doctorate and Master's degree	Clinical Applications Coordinator	120	60	120	No
Group A - 11	Male	30-39	Master's degree	Chief of Staff, Physician Assistant/Informatics	48	60	48	No
Group A - 8	Female	30-39	Doctorate degree	Clinical Informaticist	168	25	168	No
Group A - 3	Male	30-39	Doctorate degree	Clinical Informaticist	144	60	144	No
Group A - 4	Female	40-49	Doctorate degree	Clinical Applications Coordinator	240	60	240	No
Group A - 13	Male	40-49	Doctorate degree	Clinical Informaticist	180	60	204	No
Group A - 7	Female	30-39	Doctorate degree	Family Medicine Physician	24	25	24	No
Group A - 15	Male	50-59	Doctorate degree	Physician	120	60	120	No
Group A - 6	Male	40-49	Doctorate and Master's degree	Clinical Informaticist	360	60	360	No
Group A - 9	Female	40-49	Bachelor's degree	Nurse Informaticist	252	60	252	No
Group B - 2	Female	30-39	Bachelor's degree	Business Office Manager	72	60	72	No
Group B - 10	Male	30-39	Associate degree	IT Specialist	192	60	180	No
Group B - 5	Male	50-59	Associate degree	IT Specialist, CAC	216	60	192	No
Group B - 7	Female	40-49	Bachelor's degree	Supervisory Health Systems Specialist	228	25	228	No
Group B - 8	Female	30-39	Some college credit, no degree; Trade/technical/vocational training	MSA	12	25	12	No
Group B - 1	Female	30-39	Associate degree	Registration Supervisor	24	25	24	No
Group B - 9	Female	20-29	Some college credit, no degree	MSA	9	25	9	No
Group B - 11	Female	40-49	high school graduate, diploma or the equivalent	Administrative Support Assistant	96	25	96	No
Group B - 6	Female	40-49	Some college credit, no degree	Supervisory Medical Support Assistant	144	60	144	No
Group B - 12	Female	40-49	Associate Degree	Supervisory Medical Support Assistant	120	25	120	No
Group B – 3	Female	40-49	Some college credit, no degree	IT Specialist/Application Coordinator	240	60	240	No
Group C - 6	Male	40-49	Doctorate and Master's degree	Clinical Informaticist	360	60	360	No
Group C - 9	Female	40-49	Bachelor's degree	Nurse Informaticist	252	60	252	No
Group C - 8	Female	30-39	Doctorate degree	Clinical Informaticist	168	25	168	No
Group C - 5	Female	60-69	Master's degree	Clinical Application Coordinator	240	60	240	No
Group C - 14	Female	30-39	Doctorate degree	General Pediatrician	24	25	24	No
Group C - 13	Male	40-49	Doctorate degree	Clinical Informaticist	180	60	204	No

Participant Identifier	Participant Gender	Participant Age	Participant Education	Participant Occupation/Role	Participant Professional Experience (months)	Participant Computer Experience (months)	Participant Product Experience (months)	Participant Assistive Technology Needs
Group C - 20	Male	40-49	Doctorate degree	Health Systems Analyst	120	60	120	No
Group C - 17	Male	30-39	Doctorate degree	Physician/Medical Officer	72	60	72	No
Group C - 10	Male	50-59	Associate degree	IT Specialist, Clinical Application Coordinator	216	60	108	No
Group C - 19	Male	30-39	Doctorate degree	Clinical Informaticist	132	60	132	No
Group C - 2	Female	30-39	Bachelor's degree	Supervisory Clinical Nurse	96	60	96	No

Test Group	Task	Task Success Rate - Mean (%)	Task Success Rate - Standard Deviation (%)	Mean observed number of steps taken for the corresponding task	Optimal number of steps for the corresponding task
	170.315(a)(9) Clinical decision support				
A	1. Access Clinical Reminders List.	100%	0%	2	2
A	2. Select a reminder and view details.	100%	0%	3	3
A	3. Resolve the reminder.	100%	0%	4	4
A	4. Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	100%	0%	2	2
A	**170.315(a)(1) Computerized provider order entry—medications, 170.315(a)(4) Drug-drug, drug-allergy interaction checks**				
A	5. Access the patient's Orders List.	100%	0%	2	2
A	6. Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	100%	0%	12	12
A	7. Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	100%	0%	14	14
A	8. Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	100%	0%	14	14
A	9. Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	100%	0%	5	5
A	**170.315(a)(2) Computerized provider order entry—laboratory**				
A	10. Access the patient's Orders List.	100%	0%	2	2
A	11. Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	100%	0%	6	6
A	12. Change the collection date of the HgbA1c order. Accept and sign the order.	100%	0%	5	5
A	**170.315(a)(3) Computerized provider order entry—diagnostic imaging**				
A	13. Access patient's Orders List.	92%	29%	2	2
A	14. Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	92%	29%	6	6
A	15. Change the Transport method to Stretcher. Accept and sign the order.	92%	29%	5	5

Test Group	Task	Task Success Rate - Mean (%)	Task Success Rate - Standard Deviation (%)	Mean observed number of steps taken for the corresponding task	Optimal number of steps for the corresponding task
B	**170.315(a)(5) Demographics**				
B	1. Register New Patient	100%	0%	16	15
B	2. Add Preferred Language to Existing Patient	100%	0%	11	10
B	3. Edit Patient Information	100%	0%	8	7
B	4. Add SO/GI Information	100%	0%	8	7
B	5. Edit SO/GI Information	100%	0%	7	7
B	6. Update Preliminary Cause of Death	100%	0%	13	12
C	**170.315(a)(14) IDL**				
C	1. Add New Implantable Device	91%	30%	16	15
C	2. Access and change UDI and Status	82%	40%	6	6
C	3. Preview a list that contains UDIs, description, and method to access UDIs	91%	30%	5	5
C	**170.315(b)(2) CIR**				
C	4. Reconcile CCDA Problems	100%	0%	11	10
C	5. Reconcile CCDA Adverse Reactions	100%	0%	14	12
C	6. Reconcile CCDA Medications	100%	0%	16	15
C	7. Preview new CCDA with reconciled data	91%	30%	5	5

Task	Mean Task Time (seconds)	Standard Deviation for Task Time (seconds)	Observed Task Time (seconds)	Optimal Task Time (seconds)
170.315(a)(9) Clinical decision support				
1. Access Clinical Reminders List.	7	4	8	13
2. Select a reminder and view details.	12	4	8	20
3. Resolve the reminder.	46	21	38	83
4. Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	7	5	5	15
170.315(a)(1) Computerized provider order entry—medications, 170.315(a)(4) Drug-drug, drug-allergy interaction checks				
5. Access the patient's Orders List.	5	1	5	7
6. Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	71	31	45	127
7. Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	45	6	42	63
8. Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	55	10	44	81
9. Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	35	11	24	57
170.315(a)(2) Computerized provider order entry—laboratory				
10. Access the patient's Orders List.	4	2	2	7
11. Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	47	8	42	68
12. Change the collection date of the HgbA1c order. Accept and sign the order.	38	7	34	56
170.315(a)(3) Computerized provider order entry—diagnostic imaging				
13. Access patient's Orders List.	4	3	3	8
14. Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	50	24	51	92
15. Change the Transport method to Stretcher. Accept and sign the order.	20	7	27	33
170.315(a)(5) Demographics				
1. Register New Patient	282	105	223	483
2. Add Preferred Language to Existing Patient	73	29	58	127
3. Edit Patient Information	83	38	53	151
4. Add SO/GI Information	57	34	47	113
5. Edit SO/GI Information	50	18	37	85
6. Update Preliminary Cause of Death	74	29	113	128

Task	Mean Task Time (seconds)	Standard Deviation for Task Time (seconds)	Observed Task Time (seconds)	Optimal Task Time (seconds)
170.315(a)(14) IDL				
1. Add New Implantable Device	255	135	263	487
2. Access and change UDI and Status	61	55	35	145
3. Preview a list that contains UDIs, description, and method to access UDIs	41	28	30	86
170.315(b)(2) CIR				
4. Reconcile CCDA Problems	139	87	101	282
5. Reconcile CCDA Adverse Reactions	158	93	130	313
6. Reconcile CCDA Medications	129	55	77	230
7. Preview new CCDA with reconciled data	115	74	154	236

Task	Mean Task Errors (%)	Standard Deviation of Task Errors (%)
170.315(a)(9) Clinical decision support		
1. Access Clinical Reminders List.	0%	0%
2. Select a reminder and view details.	0%	0%
3. Resolve the reminder.	0%	0%
4. Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	0%	0%
170.315(a)(1) Computerized provider order entry—medications, 170.315(a)(4) Drug-drug, drug-allergy interaction checks		
5. Access the patient's Orders List.	0%	0%
6. Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	0%	0%
7. Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	0%	0%
8. Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	0%	0%
9. Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	0%	0%
170.315(a)(2) Computerized provider order entry—laboratory		
10. Access the patient's Orders List.	0%	0%
11. Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	0%	0%
12. Change the collection date of the HgbA1c order. Accept and sign the order.	0%	0%
170.315(a)(3) Computerized provider order entry—diagnostic imaging		
13. Access patient's Orders List.	0%	0%
14. Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	0%	0%
15. Change the Transport method to Stretcher. Accept and sign the order.	0%	0%
170.315(a)(5) Demographics		
1. Register New Patient	0%	0%
2. Add Preferred Language to Existing Patient	0%	0%
3. Edit Patient Information	9%	30%
4. Add SO/GI Information	0%	0%
5. Edit SO/GI Information	0%	0%
6. Update Preliminary Cause of Death	0%	0%

Task	Mean Task Errors (%)	Standard Deviation of Task Errors (%)
170.315(a)(14) IDL		
1. Add New Implantable Device	0%	0%
2. Access and change UDI and Status	0%	0%
3. Preview a list that contains UDIs, description, and method to access UDIs	0%	0%
170.315(b)(2) CIR		
4. Reconcile CCDA Problems	9%	30%
5. Reconcile CCDA Adverse Reactions	9%	30%
6. Reconcile CCDA Medications	0%	0%
7. Preview new CCDA with reconciled data	0%	0%

Task	Task Rating - Scale Type	Mean Task Rating (1-5)	Mean Task Rating Standard Deviation (1-5)
170.315(a)(9) Clinical decision support			
1. Access Clinical Reminders List.	Likert Scale	5	0
2. Select a reminder and view details.	Likert Scale	5	0
3. Resolve the reminder.	Likert Scale	5	0
4. Refresh the Clinical Reminders list and confirm that the reminder has been resolved.	Likert Scale	5	0
170.315(a)(1) Computerized provider order entry—medications, 170.315(a)(4) Drug-drug, drug-allergy interaction checks			
5. Access the patient's Orders List.	Likert Scale	4.67	0.78
6. Place order for Warfarin. Accept and sign the order. Refresh the list and view that the order has been added. (Successful order test)	Likert Scale	4.67	0.78
7. Place order for Penicillin. Accept but do not sign the order. Confirm that the order has been added. (Test trigger for a drug-allergy alert)	Likert Scale	4.67	0.78
8. Change the Penicillin order for to Erythromycin. (Test trigger for drug-drug interaction alert)	Likert Scale	4.67	0.78
9. Accept and sign order. Confirm that the order has been added. (Test justification for bypassing the alert)	Likert Scale	4.67	0.78
170.315(a)(2) Computerized provider order entry—laboratory			
10. Access the patient's Orders List.	Likert Scale	4.83	0.58
11. Place HgbA1c lab order. Accept but do not sign the order. Confirm that the order has been added.	Likert Scale	4.83	0.58
12. Change the collection date of the HgbA1c order. Accept and sign the order.	Likert Scale	4.83	0.58
170.315(a)(3) Computerized provider order entry—diagnostic imaging			
13. Access patient's Orders List.	Likert Scale	4.67	1.15
14. Place order for x-ray of left ankle. Accept but do not sign the order. Confirm that the order has been added.	Likert Scale	4.67	1.15
15. Change the Transport method to Stretcher. Accept and sign the order.	Likert Scale	4.67	1.15

Task	Task Rating - Scale Type	Mean Task Rating (1-5)	Mean Task Rating Standard Deviation (1-5)
170.315(a)(5) Demographics			
1. Register New Patient	Likert Scale	4.82	0.60
2. Add Preferred Language to Existing Patient	Likert Scale	4.82	0.60
3. Edit Patient Information	Likert Scale	4.82	0.60
4. Add SO/GI Information	Likert Scale	5.00	0.00
5. Edit SO/GI Information	Likert Scale	5.00	0.00
6. Update Preliminary Cause of Death	Likert Scale	5.00	0.00
170.315(a)(14) IDL			
1. Add New Implantable Device	Likert Scale	4.09	1.38
2. Access and change UDI and Status	Likert Scale	3.91	1.64
3. Preview a list that contains UDIs, description, and method to access UDIs	Likert Scale	4.64	1.21
170.315(b)(2) CIR			
4. Reconcile CCDA Problems	Likert Scale	4.82	0.6
5. Reconcile CCDA Adverse Reactions	Likert Scale	4.45	0.93
6. Reconcile CCDA Medications	Likert Scale	4.82	0.6
7. Preview new CCDA with reconciled data	Likert Scale	4.64	1.21

IHS RESOURCE AND PATIENT MANAGEMENT SYSTEM

SUMMATIVE USABILITY TESTING REPORT

Version: 2.0

Date: 8/18/2021

Dates of Testing: 6/1/2021-6/11/2021

System Test Laboratory:

Contact Person: Jason Nakai, Information Architect/Usability Engineer, IHS Contractor
Email Address: Jason.Nakai@IHS.gov
Mailing Address: 5600 Fishers Lane, Rockville, MD 20857

Version History

Date	Version	Revised By:	Revision/Change Description
7/30/2021	1.0	Jason Nakai	Initial Draft
8/18/2021	2.0	Jason Nakai	Updated

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1.0 Executive Summary

A summative usability test (hereinafter referred to as “usability test”) of the Electronic Heath Record (EHR) application was conducted during the months of May and June 2021 as part of the 21st Century Cures Act (21st CCA) (g)(3) Safety-Enhanced Design criterion. The purpose of this test was to evaluate and validate the usability of the current user interface, and provide evidence of user-centered design (UCD) practices in the application.

During the usability test, healthcare providers and other users matching the target demographic criteria participated in summative usability testing for each safety-enhanced design criterion and the associated capabilities.

This study collected performance data on the top tasks as identified by the owners of the criteria to be tested.

The criteria included in this test report are:

- (b)(3) ePrescribing (eRX)

During the approximately 60-minute one-on-one usability test sessions, each participant was greeted by the administrator who introduced the test. Participants were asked to share their prior EHR experience. The administrator logged in to the application and then passed control over to the participant to complete a series of tasks (given one at a time) using the application.

During each test session, the administrator timed the test and recorded user performance data. Participant screens and audio were also recorded for subsequent analysis.

The following types of data were collected for each participant:

- Demographic data
- Number of tasks successfully completed
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant’s verbalizations (comments)
- Participant’s satisfaction ratings of the system

All participant data was de-identified so that no correspondence could be made from the identity of the participant to the data collected.

The test method and metrics were based on the National Institute of Standards and Technology (NIST) Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741). Modifications were made where necessary to better evaluate the application against the contract goals and requirements. Following the conclusion of the test, participants were asked to complete a post-test questionnaire and were thanked for their participation.

The Task Satisfaction Rating is based on the following pre-defined of 1 (Very Difficult) to 5 (Very Easy). These data are averaged across participants.

1.1 Major Findings

Based on the score of the Task Satisfaction Rating, the participants found the eRX component of the EHR easy to use.

Participants did state that the initial learning curve is steep and training is necessary. However, once they learned to use the application, participants completed tasks with great efficiency and effectiveness.

Most test participants felt the components were consistent and functioned as expected. The majority found the RPMS EHR to be an effective tool for completing their work tasks.

The top issues the test participants remarked on were:

- Font size and contrast made readability difficult
- Text was unable to be resized
- Button and menu text was not clear or intuitive
- More instructions especially for the functionality of the notes area that activates the action buttons (i.e. Approve, Accept, etc.)
- The right-click menus are not intuitive. Users did not know that they had to right-click to find the available actions

Tasks	Task Success	Task Satisfaction Rating (Scale 0-2)
	Mean %	% Rated 2 – Completed Easily
1. Create new prescription	100%	91%
2. Change prescription	91%	82%
3. Renew prescription	100%	82%
4. Cancel prescription	100%	100%

Table 1: Criteria Success and Satisfaction Rating Summary

1.2 Recommendations

Specific recommendations for the criteria are as follows:

- Default font size and contrast should be readable enough to meet Web Content Accessibility Guidelines (WCAG) 2.0 Level AA success criterion 1.4.3 Contrast (Minimum)
- Text size should be able to be increased by the end user to a minimum of 200% to meet WCAG 2.0 Level AA success criterion 1.4.4 Resize text
- Review all micro text to ensure that meaning and intent is clear
- Spell out acronyms
- Add clear and understandable instructions, hints or tool tips for complex or unintuitive actions. Examples of such actions include right-clicking on a change request to see the options available, and scrolling down to the bottom of a page to activate an approval button.

General recommendations for future development suggest that usability activities continue to be part of the development process for projects and/or products that involve user interfaces, and that usability lessons learned continue to be documented for potential future improvements.

2.0 Introduction

The Office of the National Coordinator for Health Information Technology (ONC) Health IT Certification Program is a voluntary certification program established by the Office of the National Coordinator for Health IT to provide for the certification of health IT.

The Indian Health Service (IHS) Office of Information Technology (OIT) has requested that the Resource and Patient Management System Electronic Health Record (RPMS EHR) achieve certification as part of the 21st CCA. As part of the certification criteria, (g)(3) Safety-Enhanced Design requires that summative usability testing be performed on specific criteria and the test data be provided as part of a final test report. The test report will follow the National Institute of Standards and Technology (NIST) Customized Common Industry Format Template for Electronic Health Record Usability Testing (NISTIR 7742).

Summative usability testing is a task-based evaluation that measures the ease of use of a completed product. The results are analyzed and compared to the usability requirements to determine if those requirements have been met.

2.1 Purpose

The purpose of this test was to evaluate and validate each safety-enhanced design criterion and the associated capabilities. The test ensures that the completed product meets the 21st CCA certification requirements concerning user-centered and safety-enhanced design.

2.2 Scope

The scope of usability testing is limited to testing user-involved tasks. Automated tasks or tasks without user interaction are not covered in this test. Functional testing is not covered in detail. Functionality is only tested as it pertains to the usability of the product or feature being tested.

The test was limited in scope to the following criterion:

- (b)(3) ePrescribing

3.0 Method

See Appendix A for Participant and Test data.

The test method and metrics were based on the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741). Modifications were made where necessary to better evaluate the application against the contract goals and requirements.

The objective of this test was to uncover areas where the application performed well and areas where the application failed to meet the usability needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same EHR capability and/or comparison with other EHR capabilities provided the same tasks are used. This testing serves as both a means to record or benchmark current usability and to identify areas where improvements must be made.

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

- Number of tasks successfully completed
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system (Task Satisfaction Rating)
    - 1(Very Difficult to 5 (Very Easy)

3.1 Roles and Responsibilities

Role/Function	Responsibilities
Project Manager/Criteria Owner	Responsible for the management, monitoring and tracking of the project and oversees all areas.
Usability Test Lead / Test Administrator	• Ensures that usability testing is conducted successfully and meets all usability testing deadlines. • Provides application systems analysis for application testing activities. • Prepares required documentation at the program level for testing activities. • Monitors and escalates risks or concerns about achieving goals or meeting schedules to program leadership. • Prepares all testing instructions, scripts and materials for use in the testing session. • Performs analysis of testing results, prepares and delivers test report. • Moderates the test • Collects test data
Test Observers	• Provide any needed training or support • Monitor the testing session
Test Participants	• Complete the assigned tasks • Provide honest feedback on their experience

Table 3: Roles and Responsibilities

3.1.1 Test Participants

There was a total of 11 test participants for this round of testing.

Participants in this test were:

- typical end-users such as physicians and medical providers
- trained to use the application prior to usability testing
- recruited by the 21st CCA project team and IHS criteria owners
- not compensated for participation
- had no direct connection to the development of the application
- given the same orientation and level of training as the actual end users
- assigned a participant ID initially based on scheduling order

Once participants were identified, they were scheduled for 60-minute one-on-one web conferencing (Skype, Adobe Connect) sessions. A calendar was used to keep track of the participants' schedule and a spreadsheet tracked participants' location (site) and contact information.

3.2 Test Location

The test was conducted remotely via the use of video conferencing and desktop sharing software (Microsoft Skype for Business, Adobe Connect).

3.3 Test Environment

The test participants were physically located at their normal duty stations, logged into their assigned workstations, and connected to the video conferencing software. The test administrator and observers were also physically distributed and connected via video conferencing software.

The test administrator shared his screen and was the only desktop visible during testing. Participants were given control of the test application through the test administrator's screen and used a mouse and keyboard when interacting with the application.

Technically, the system performance (i.e., response time) was not representative to what actual users would experience in a field implementation, as they were working through the test administrator's workstation and not their own.

3.4 Test Tools

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

1. Demographic Questionnaire
2. Moderator's Guide
3. Post-test Questionnaire

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

Video conferencing software (MS Skype, Adobe Connect) was used to connect participants, the administrator and observers. This software was also used to record the video and audio of test sessions.

3.5 Tasks

The testing scenarios and tasks were constructed to be realistic and representative of the kinds of activities a user would perform using the capabilities being tested. Tasks were chosen with the test objectives in mind to ensure that participants provided the most meaningful data possible. The tasks were arranged to facilitate a typical end-user workflow.

The testing tasks include:

1. Create new prescription
2. Change prescription
3. Renew prescription
4. Cancel prescription

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

3.6 Procedure

Upon arrival, each participant was greeted by the administrator and matched to a name on the participant schedule. The participant was then assigned a participant ID.

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

Each participant was instructed to perform the tasks:

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

Each participant used the same application version and was provided with the same set of instructions.

The administrator logged into the test environment and then instructed the user to request control. After log in, the user was instructed to complete a series of tasks (given one at a time) using the application. The participant was given a written copy of each task, and the administrator also read each task aloud and ensured the participant understood the task.

Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated that the task was successfully completed.

Scoring is discussed in Section 3.7 Usability Metrics.

After completion of the testing tasks, the administrator gave the participant a post-test questionnaire (System Usability Scale), asked if they had any questions, and thanked them for their participation.

Each participant's demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire ratings were recorded into the participant spreadsheet.

Following each test session, the video recordings were reviewed and checked against the data logged in the participant spreadsheet. The participant spreadsheet was updated with any edits or additional information such as verbalizations.

3.7 Usability Metrics

According to the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records, EHRs should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction. To this end, metrics for effectiveness, efficiency and user satisfaction were captured during the usability testing.

The goals of the test were to assess:

1. Effectiveness by measuring participant success rates and errors
2. Efficiency by measuring the average task time and path deviations
3. Satisfaction by measuring task satisfaction ratings and SUS scores

3.7.1 Data Scoring

The following table (Table 4) details how tasks were scored, errors evaluated, and the time data analyzed.

Measures	Rationale and Scoring
Effectiveness: Task Success	A task was counted as a "Success" if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis. The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage. Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency. Optimal task performance time, as benchmarked by expert performance under realistic conditions, is recorded when constructing tasks. Target task times used for task times in the Moderator's Guide must be operationally defined by taking multiple measures of optimal performance and multiplying by some factor [e.g., 1.25] that allows some time buffer because the participants are presumably not trained to expert performance. Thus, if expert, optimal performance on a task was [x] seconds then allotted task time performance was [x * 1.25] seconds. This ratio should be aggregated across tasks and reported with mean and variance scores.
Effectiveness: Task Failures	If the participant abandoned the task, did not reach the correct answer or performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as a "Failures." No task times were taken for errors. The total number of errors was calculated for each task and then divided by the total number of times that task was attempted. Not all deviations would be counted as errors.[11] This should also be expressed as the mean number of failed tasks per participant. On a qualitative level, an enumeration of errors and error types should be collected.

Measures	Rationale and Scoring
Efficiency: Task Deviations	The participant's path (i.e., steps) through the application was recorded. Deviations occur if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation.
Satisfaction: **Task Satisfaction Rating**	Participant's subjective impression of the ease of use of the application was measured by administering both a simple post-task question as well as a post-session questionnaire. After each task, the participant was asked to rate "Overall, this task was:" on a scale of 1 (Very Difficult) to 5 (Very Easy). These data are averaged across participants. Common convention is that average ratings for systems judged easy to use should be 3.3 or above. To measure participants' confidence in and likeability of the system overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. Questions included, "I think I would like to use this system frequently," "I thought the system was easy to use," and "I would imagine that most people would learn to use this system very quickly."

Table 4: Measure Scoring

4.0 Results

4.1 Data Analysis and Reporting

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above.

Participants who failed to follow session and task instructions had their data excluded from the analyses.

4.2 Discussion of Findings

Based on the score of the Task Satisfaction Rating, the participants found the EHR easy to use. Participants did state that the initial learning curve is steep and training is necessary. However, once they learned to use the application, participants completed tasks with great efficiency and effectiveness.

The path taken to complete the tasks differed from participant to participant. This was influenced by the differing configuration of the test sites' EHR UIs. In spite of the varied paths to complete tasks, time per task was minimal and consistent, and errors were virtually non-existent.

All test participants felt the components were consistent and functioned as expected. The majority found the RPMS EHR to be an effective tool for completing their work tasks. Most said they would recommend this EHR to their colleagues.

The top issues the test participants remarked on were:

- Font size and contrast made readability difficult
- Text was unable to be resized
- Button and menu text was not clear or intuitive
- More instructions especially for the functionality of the notes area that activates the action buttons (i.e. Approve, Accept, etc.)
- The right-click menus are not intuitive. Users did not know that they had to right-click to find the available actions

4.2.1 Effectiveness

#	Tasks	# Participants	Task Success Rate - Mean %	Task Success Rate - Std Dev %	Task Errors Mean %	Task Errors Std Dev %
	(b)(3) ePrescribing					
1	Create new prescription	11	100%	0%	0%	47%
2	Change prescription	11	91%	30%	0%	52%
3	Renew prescription	11	100%	0%	0%	50%
4	Cancel prescription	11	100%	0%	0%	0%

Table 5: Effectiveness

4.2.2 Efficiency

#	Tasks	Observed # Steps	Optimal # Steps	Task Time Observed Mean (seconds)	Task Time Std Dev (seconds)	Task Time Optimal (seconds)
	(b)(3) ePrescribing					
1	Create new prescription	12	11	207	161	250
2	Change prescription	12	12	146	52	236
3	Renew prescription	14	14	128	42	180
4	Cancel prescription	4	4	46	15	90

Table 6: Efficiency

4.2.3 Satisfaction

#	Tasks	# Participants	Task Rating Likert Scale	Task Rating Mean	Task Rating Std Dev
	(b)(3) ePrescribing				
1	Create new prescription	11	1-5	4.82	0.60
2	Change prescription	11	1-5	4.45	1.29
3	Renew prescription	11	1-5	4.64	0.81
4	Cancel prescription	11	1-5	5.00	0.00

Table 7: Satisfaction

4.2.3.1 System Usability Scale (SUS)

The results from the System Usability Scale (SUS) from the post-test questionnaire, scored the subjective satisfaction with the system based on performance with the listed testing tasks by group.

System Usability Scale (SUS) Score	Score
(b)(3) ePrescribing	77.05

Table 8: SUS Scores

According to usability.gov, "[b]ased on research, a SUS score above a 68 would be considered above average and anything below 68 is below average".

4.2.4 Major Findings

Based on the score of the Task Satisfaction Rating, the participants found the eRx component of the EHR easy to use.

Participants did state that the initial learning curve is steep and training is necessary. However, once they learned to use the application, participants completed tasks with great efficiency and effectiveness.

Most test participants felt the components were consistent and functioned as expected. The majority found the RPMS EHR to be an effective tool for completing their work tasks.

The top issues the test participants remarked on were:

- Font size and contrast made readability difficult
- Text was unable to be resized
- Button and menu text was not clear or intuitive
- More instructions especially for the functionality of the notes area that activates the action buttons (i.e. Approve, Accept, etc.)
- The right-click menus are not intuitive. Users did not know that they had to right-click to find the available actions

4.2.5 Recommendations

Overall recommendations focus on more effectively communication meaning to the end user, as well as enhancing readability. Specific recommendations for the criteria are as follows:

- Default font size and contrast should be readable enough to meet Web Content Accessibility Guidelines (WCAG) 2.0 Level AA success criterion 1.4.3 Contrast (Minimum)
- Text size should be able to be increased by the end user to a minimum of 200% to meet WCAG 2.0 Level AA success criterion 1.4.4 Resize text
- Review all micro text to ensure that meaning and intent is clear
- Spell out acronyms
- Add clear and understandable instructions, hints or tool tips for complex or unintuitive actions. Examples of such actions include right-clicking on a change request to see the options available, and scrolling down to the bottom of a page to activate an approval button.

5.0 Acronym List

Acronym	Description
CCA	21st Century Cures Act
EHR	Electronic Health Record
eRX	ePrescribing
IHS	Indian Health Service
ISO	International Organization for Standardization
NIST	National Institute of Standards and Technology
OIT	Office of Information Technology
RPMS	Resource and Patient Management System
SESS	Software Engineering Support Services
UI	User Interface
WCAG	Web Content Accessibility Guidelines

Table 23: Acronyms

6.0 Appendix A: Participant and Test Result Data

Participant Identifier	Participant Gender	Participant Age	Participant Education	Participant Occupation/Role	Participant Professional Experience (months)	Participant Computer Experience (months)	Participant Product Experience (months)	Participant Assistive Technology Needs
TP1	Female	30-39	Pharm D	Clinical Informaticist	20	8	16	None
TP2	Female	40-49	Master's Degree	Clinical Informaticist	27	13	13	None
TP3	Female	40-49	Bachelor's Degree	Clinical Nurse Case Manager	30	18	9	None
TP5	Male	40-49	Doctorate, Master's Degree	Health Informaticist	30	13	13	None
TP8	Female	30-39	Doctorate	Pediatrician	25	5	2	None
TP9	Male	40-49	Pharm D	Health Systems Specialist	25	2	10	None
TP10	Male	50-59	Doctorate	Subject Matter Expert Physician	30	2	15	None
TP13	Male	50-59	AA Degree	IT Specialist, CAC	35	6	1	None
TP14	Female	30-39	Bachelor's Degree	Nurse Consultant	30	1	9	None
TP15	Male	40-49	Pharm D	Pharmacy Consultant, Clinical Informaticist	40	15	25	None
TP17	Male	70-79	Doctorate	Subject Matter Expert Physician	40	3	19	None

Task	Task Success Rate - Mean (%)	Task Success Rate - Standard Deviation (%)	Mean observed number of steps taken for the corresponding task	Optimal number of steps for the corresponding task
1. Create new prescription	100%	0%	12	11
2. Change prescription	91%	30%	12	12
3. Renew prescription	100%	0%	14	14
4. Cancel prescription	100%	0%	4	4

Task	Task Rating - Scale Type	Mean Task Rating (1-5)	Mean Task Rating Standard Deviation (1-5)
1. Create new prescription	Likert Scale	4.82	0.60
2. Change prescription	Likert Scale	4.45	1.29
3. Renew prescription	Likert Scale	4.64	0.81
4. Cancel prescription	Likert Scale	5.00	0.00

Task	Mean Task Time (seconds)	Standard Deviation for Task Time (seconds)	Observed Task Time (seconds)	Optimal Task Time (seconds)
1. Create new prescription	207	161	159	250
2. Change prescription	146	52	113	236
3. Renew prescription	128	42	95	180
4. Cancel prescription	46	15	42	90

Task	Mean Task Errors (%)	Standard Deviation of Task Errors (%)
1. Create new prescription	27%	47%
2. Change prescription	45%	52%
3. Renew prescription	36%	50%
4. Cancel prescription	0%	0%

IHS RESOURCE AND PATIENT MANAGEMENT SYSTEM

Health Information Technology Systems and Support

Summative Usability Testing

Report

Version 1.0
November 2024

Office of Information Technology
Division of Information Technology

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Preface

This document presents the Summative Usability Testing for §170.315 (b)(11) Decision Support Intervention for the IHS Resource and Patient Management System Electronic Health Record BCER v8.2 application.

1.0 Executive Summary

From September 24, 2024, through October 3, 2024, a summative usability test of the IHS Resource and Patient Management System Electronic Health Record BCER v8.2 application evaluated new Clinical Reminder features: Source Attributes, and the Clinical Reminder Feedback form. This test aimed to validate the User-Centered Design (UCD) of these updates in alignment with the Health Data, Technology, and Interoperability (HTI-1) program requirements, which emphasize certification, transparency, and safety. Results support that the EHR's updated features meet UCD best practices, addressing both §170.315(g)(3) Safety-enhanced design and §170.315(b)(11) Decision Support Intervention (DSI) certification criteria. The UCD is functional, accessible and intuitive.

The intended users for this application are healthcare providers and healthcare management. This study collected performance data tasks identified by the project team and involved participants matching the target demographic criteria.

During the approximately 60-minute one-on-one usability test sessions, each participant was greeted by the administrator who introduced the test. The participant logged in to the application to complete a series of tasks (given one at a time) using the application.

During each test session, the administrator timed the test and recorded user performance data. Participant screens and audio were also recorded for subsequent analysis.

The following types of data were collected for each participant:

- Demographic data
- Number of tasks successfully completed
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system

All participant data was de-identified so that no correspondence could be made from the identity of the participant to the data collected.

The test method and metrics were based on the National Institute of Standards and Technology (NIST) Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)[i]. The NISTIR 7741, provides a detailed set of guidelines to improve the usability, safety, and effectiveness of EHR systems. These guidelines focus on human-centered design principles to enhance user interaction, reduce errors, and optimize workflow efficiency in clinical environments. This report outlines best practices, usability evaluation methods, and design principles to ensure EHRs support healthcare providers effectively while improving patient care.

Following the conclusion of the test, participants were asked to complete a post-test questionnaire and were thanked for their participation.

The Task Satisfaction Rating is based on the following pre-defined scale:

- 0 – The tester is unable to complete the task.
- 1 – The tester is able to complete the task with some difficulty.
- 2 – The tester is able to complete the task easily.

1.1 Major Findings

Users found the new features implemented on the Clinical Reminders easy to access and convenient to use. The majority found it to be resourceful and effective, to find additional source information on Clinical Reminders and the ability to submit feedback on Clinical Reminders. However, communicating the purpose and process was not completely clear to users. The user experience could be improved by making modifications to design elements to improve UCD.

The top issues the test participants remarked on were:

- Clinical sites did not have text next to the clock icon that could help distinguish the Clinical Reminders. (See section 4.2.4.1)
- Unnecessary additional clicks to access the Source Attributes and Clinical Reminder Form. (See section 4.2.4.1)
- Unclarity in accessing the right-click functionality on Clinical Reminders. (See section 4.2.4.1)

[i] National Institute of Standards and Technology, *NISTIR 7741: Usability Guidelines for Electronic Health Records (EHRs)*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7741-nist-guide-processes-approach-improving-usability-electronic-health-records

- The naming conventions on these new features were difficult to understand. (See section 4.2.4.2)
- Navigating through the Evidence Based Decision Support Intervention Source Attributes document was difficult because it was categorized by year instead of alphabetically. (See section 4.2.4.3)
- Inconsistent document structure, missing source information, and information overload on Clinical Reminder source list. (See section 4.2.4.3)
- Uncertainty on Clinical Reminder Form purpose and options: Important Message, Category, Application, Priority, Actions Taken on Reminder, (See section 4.2.4.4)
- Success state on Clinical Reminder Form was not as effective. (See section 4.2.4.4)
- Clarity on form to allow users to fill out more efficiently. (See section 4.2.4.5)
- Improvement on design changes of interactive and disabled text fields. (See section 4.2.4.6)
- Improvement and clarity of usage for drop down selection within a specific text field. (See section 4.2.4.7)

Detailed findings as well as additional issues identified by the test participants will be discussed in Section 4.2, Discussion of Findings.

Table 1-1: Criteria Success and Satisfaction Rating Summary

Tasks	Task Success	Task Satisfaction Rating (Scale 0-2)
	Mean %	% Rated 2 – Completed Easily
1. Find the Reminder Source Attribute Dialog	100%	100%
2. Find Specific Citation Information within the Source Attribute Webpage	100%	90%
3. Access the Reminder Feedback Form Through the EHR application	100%	100%
4. Fill out the Clinical Reminder Feedback Form	100%	90%

1.2 Recommendations

Specific recommendations for the application are as follows:

- Reduce the number of additional clicks to access the Source Attributes and Clinical Reminder Form when right-clicking a Clinical Reminder.

- Make it clear to the user that they can access additional options by right-clicking a Clinical Reminder.
- Change the ordered list and naming to the following: Clinical Maintenance, Reminder Inquiry, Education Topic Definition, Additional Source Details, National Reminder Feedback, Evaluate Reminder, Reminder Icon Legend.
- Include text Clinical Reminders next to the clock icon for all sites.
- Change the title to, "Additional Source Details for VA Clinical Reminders (PXRM)."
- Categorize the sources alphabetically, followed by year.
- Align all source information to the left, and include the following: a table of contents, headings, and missing information such as page numbers, citations for certain clinical reminders and age ranges.
- The Important Message should be reworded to state, "Local sites experiencing issues please contact your Clinical Application Coordinator (CAC). This form is intended for feedback on National clinical reminders only."
- Auto-populate the text field, "Name of Reminder," to help the user recognize and specify the reminder name.
- Move the Category option to top of the form and do not default it to "General Comment." Increase spacing in between each option and make it responsive for smaller screens.
- Remove the Application field and include the application name in the description of the form.
- Change the title to "Provide National Feedback for VA Clinical Reminders (PXRM)."
- Include time frames for Priority options, Routine and Urgent. This can include days, weeks, or months).
- Reword options on "Actions Taken on Reminder" and remove it being defaulted to "Acknowledged the Reminder."
  - "Acknowledged the Reminder" to "Evaluated the Reminder."
  - Remove "Skipped the Reminder."
- Include text below the "Attachments" option, "Do not include Personal Identifiable Information (PII) in this form."
- Change the text color from red to green, "Your feedback has been submitted! An Email has been sent by this system to notify the proper individuals and a copy was sent to the Email address you registered with this Feedback item."

General recommendations for future development suggest that usability activities continue to be part of the development process for projects and/or products that involve user interfaces, and that usability lessons learned continue to be documented for potential future improvements.

2.0 Introduction

The Health Data, Technology, and Interoperability (HTI-1) program introduces updates to certification, algorithm transparency, and information sharing, requiring §170.315(g)(3) Safety-enhanced design to implement user-centered design and conduct summative usability testing on the newly implemented features for §170.315(b)(11) Decision Support Intervention (DSI) criteria. These features include the Clinical Reminder Source Attribute and Clinical Reminders Feedback form.

In addition, the summative usability test report will follow the National Institute of Standards and Technology (NIST) Customized Common Industry Format Template for Electronic Health Record Usability Testing (NISTIR 7742)[ii]. Summative usability testing is a task-based evaluation that measures the ease of use of a completed product. The results are analyzed and compared to the usability requirements to determine if those requirements have been met.

2.1 Purpose

The purpose of this test is to evaluate and validate the current usability of the new EHR Clinical Reminders features implemented, this includes the Clinical Reminders Feedback Form & the Source Attribute, as well as identify any areas of improvement.

2.2 Scope

The scope of usability testing is limited to testing user-involved tasks. Automated tasks or tasks without user interaction are not covered in this test. Functional testing is not covered in detail. Functionality is only tested as it pertains to the usability of the product or feature being tested.

[ii] National Institute of Standards and Technology, *NISTIR 7742: Customized Common Industry Format Template for Electronic Health Record Usability Testing*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7742-customized-common-industry-format-template-electronic-health-record

3.0 Method

The test method and metrics were based on the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)[iii].

The objective of this test was to uncover areas where the application performed well and areas where the application failed to meet the usability needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same application capability and/or comparison with other application capabilities provided the same tasks are used. This testing serves as both a means to record or benchmark current usability and to identify areas where improvements must be made.

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

- Number of tasks successfully completed.
- Time to complete the tasks.
- Number and types of errors.
- Path deviations.
- Participant's verbalizations (comments).
- Participant's satisfaction ratings of the system (Task Satisfaction Rating).
  - 0 – Could not complete the task.
  - 1 – Completed the task with some difficulty.
  - 2 – Completed the task easily.

3.1 Roles and Responsibilities

Table 3-1: Roles and Responsibilities

Role/Function	Responsibilities
Project Manager/Criteria Owner	• Responsible for the management, monitoring, and tracking of the project and oversees all areas.

[iii] National Institute of Standards and Technology, *NISTIR 7741: Usability Guidelines for Electronic Health Records (EHRs)*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7741-nist-guide-processes-approach-improving-usability-electronic-health-records

Role/Function	Responsibilities
Usability Test Lead / Test Administrator	• Ensures that usability testing is conducted successfully and meets all usability testing deadlines. • Provides application systems analysis for application testing activities. • Prepares required documentation at the program level for testing activities. • Monitors and escalates risks or concerns about achieving goals or meeting schedules to program leadership. • Prepares all testing instructions, scripts, and materials for use in the testing session. • Performs analysis of testing results, prepares and delivers test report. • Moderates the test. • Collects test data.
Test Participants	• Complete the assigned tasks. • Provide honest feedback on their experience.

3.1.1 Test Participants

There were a total of 10 test participants for this round of testing. Participants in this test were:

- Typical end-users.
- Trained to use the application prior to usability testing.
- Recruited by PXRM project team.
- Not compensated for participation.
- Assigned a participant ID at random.

Once participants were identified, they were scheduled for 60-minute one-on-one web conferencing sessions. A calendar was used to keep track of the participants' schedule, and a spreadsheet tracked participants' location (site) and contact information.

3.2 Test Location

The test was conducted remotely via the use of video conferencing and desktop sharing software (Microsoft Teams).

3.3 Test Environment

The test participants were physically located at their normal duty stations, logged into their assigned workstations, and connected to the video conferencing software. The test administrator was also physically distributed and connected via video conferencing software.

The test participants shared their screen during testing. The response time was representative to what actual users would experience in a field implementation.

3.4 Test Tools

Before and after the usability test, various forms were used, including:

- Demographic & Application Survey
- Moderator's Guide
- Post-test Questionnaire

Video conferencing software was used to connect participants with the administrator. This software was also used to record the video and audio of test sessions.

3.5 Task Scenarios

The testing and step by step tasks were constructed to be a representative of the kinds of activities a user would perform using the capabilities being tested. Tasks were chosen with the test objectives in mind to ensure that participants provided the most meaningful data possible. The tasks were arranged to facilitate a typical end-user workflow.

The moderated testing scenarios and associated tasks include:

- Find the Reminder Source Attribute Dialog in the EHR application.
    - The user must click on the clock icon, labeled as "Clinical Reminders" in the navigation menu. A dialog box appears on the left side with a list of reminders. The user then chooses to select 'Reference Information', followed by 'Reminder Source Attributes' from the list. The user then confirms when the browser pop-up appears.
- Find & Access Citation Information within the Source Attribute Webpage.

    - While on the directed webpage, the user clicks on the link "Evidence-Based Decision Intervention Source Attributes". The user then finds the 'IHS Height 2013' on the third page and finds the Bibliographic Citation information. The user then reads the Bibliographic Citation information out loud.
- Access the Reminder Feedback Form Through the EHR application.
    - The user navigates back to the application. The dialog that was previously opened will still be there. The user then will right click on a reminder, selects 'Reference Information', clicks on 'Clinical Reminder Feedback'. The user then confirms when the browser pop-up appears.
- Fill out the Clinical Reminder Feedback Form.
    - The user then fills out their personal details: first name, last name, email, confirms email. Then provides issue information details: subject, category, priority, reminder name, clinical/hospital name, and actions taken on reminder. The user then enters feedback and then sends the form.

These tasks encompass newly implemented features that need certification testing for HTI-1. Given the recent updates to the user interface and user experience, these tasks are expected to effectively evaluate functionality and performance with participants.

3.6 Procedure

Upon arrival, each participant was greeted by the administrator and matched to a name on the participant schedule. The test administrator moderated the test session including administering instructions and tasks. The administrator also monitored task times, obtained post-task rating data, and took notes on participant comments.

Each participant was instructed to perform the tasks:

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

Each participant used the same application version. The instructions were modified after the third participant to include missing instructions when users had to fill out the Clinical Reminder form. These included providing the Category and Actions Taken on Reminder text fields. The Category uses would select Application Problem, and Actions Taken on Reminder is defaulted to Acknowledged the Reminder. The instructions were more direct to the user after these modifications.

In addition, there were modifications to word instructions to help make the testing process clearer. This included changing the word from “Submit” to “Send,” since that is what was shown to users in the feedback form.

The test participant logged into the test environment. After login, the user was instructed to complete a series of tasks (given one at a time) using the application. The participant was given a written copy of each task, and the administrator also read each task aloud and ensured the participant understood the task. Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated that the task was completed.

Scoring is discussed in Section 3.7, Usability Metrics.

After completion of the testing tasks, the administrator gave the participant a post-test questionnaire (System Usability Scale), asked if they had any questions, and thanked them for their participation.

Each participant’s demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire ratings were recorded into the participant spreadsheet.

Following each test session, the video recordings were reviewed and checked against the data logged in the participant spreadsheet. The participant spreadsheet was updated with any edits or additional information such as verbalizations.

3.7 Usability Metrics

According to the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records, EHRs and supporting applications should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction. To this end, metrics for effectiveness, efficiency, and user satisfaction were captured during the usability testing.

The goals of the test were to assess the following:

- Effectiveness by measuring participant success rates and errors.
- Efficiency by measuring the average task time and path deviations.
- Satisfaction by measuring task satisfaction ratings and SUS scores.

3.7.1 Data Scoring

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

Table 3-2: Data Scoring Methodology

Measures	Rationale and Scoring
Effectiveness: Task Success	A task was counted as a "Success" if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis. The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage. Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency. Optimal task performance time, as benchmarked by expert performance under realistic conditions, is recorded when constructing tasks. Target task times used for task times in the Moderator's Guide must be operationally defined by taking multiple measures of optimal performance and multiplying by some factor [e.g., 1.25] that allows some time buffer because the participants are presumably not trained to expert performance. Thus, if expert, optimal performance on a task was [x] seconds then allotted task time performance was [x * 1.25] seconds. This ratio should be aggregated across tasks and reported with mean and variance scores.
Effectiveness: Task Failures	If the participant abandoned the task, did not reach the correct answer or performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as a "Failures." No task times were taken for errors. The total number of errors was calculated for each task and then divided by the total number of times that task was attempted. Not all deviations would be counted as errors.11 This should also be expressed as the mean number of failed tasks per participant. On a qualitative level, an enumeration of errors and error types should be collected.
Efficiency: Task Deviations	The participant's path (i.e., steps) through the application was recorded. Deviations occur if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation.

Measures	Rationale and Scoring
Efficiency: Task Time	The workflow was timed from the moment the participant said "begin" until they said "done." If the participant failed to say "done," timing ceased when they stopped performing the tasks. Only workflows that were successfully completed were included in the time analysis. The average time for the workflow was calculated, along with variance measures, including standard deviation and standard error.
Satisfaction: Task Satisfaction Rating	User satisfaction is rated using the Task Satisfaction Rating. Performance Standard: 80% of tested users complete the testing tasks, as specified by the customer, easily during summative usability testing, using the following scale: 0 – Unable to complete the task. 1 – Completed the task with some difficulty. 2 – Completed the task easily. To measure participants' confidence in and likeability of the system overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. Questions included, "I think I would like to use this system frequently," "I thought the system was easy to use," and "I would imagine that most people would learn to use this system very quickly."

4.0 Results

4.1 Data Analysis and Reporting

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above.

Participants who failed to follow session and task instructions had their data excluded from the analyses.

4.1.1 Effectiveness, Efficiency & Satisfaction Data

Table 4-1: Effectiveness

Task Identifier	Task Description	# Participants	Success Rate	Standard Deviation
b11.1	Find the Reminder Source Attribute Dialog in the EHR application.	10	100%	0%
b11.2	Find Specific Citation Information within the Source Attribute Webpage.	10	100%	0%
b11.3	Access the Reminder Feedback Form Through the EHR application.	10	100%	0%
b11.4	Fill out the Clinical Reminder Feedback Form.	10	100%	0%

Table 4-2: Efficiency

Task Identifier	Observed # Steps	Optimal # Steps	Task Time Mean (seconds)	Task Time Std Dev (seconds)	Task Time Deviation Observed (seconds)	Task Time Deviation Optimal (seconds)	Task Errors Mean	Task Errors Std Dev	Task Rating-Scale Type	Task Ratings Mean	Task Ratings Std Dev
b11.1	4	4	36	28	20	22	0%	0%	Likert	5	0%
b11.2	4	4	40	12	9	9	0%	0%	Likert	4.80	0.63%
b11.3	4	4	19	8	6	7	0%	0%	Likert	5	0%
b11.4	5	4	107	32	24	55	0.8%	1.03%	Likert	4.80	0.63%

Table 4-3: Task Satisfaction Rating (0-Cannot complete task, 1-Completed with difficulty, 2-Completed easily)

Task Identifier	Task	% Rated 2-Completed Easily
b11.1	Find the Reminder Source Attribute Dialog in the EHR application	100%
b11.2	Find Specific Citation Information within the Source Attribute Webpage	90%
b11.3	Access the Reminder Feedback Form Through the EHR application	100%
b11.4	Fill out the Clinical Reminder Feedback Form	90%

4.1.1.1 System Usability Scale (SUS)

The results from the System Usability Scale (SUS) from the post-test questionnaire scored subjective satisfaction with the system based on performance with the listed testing tasks by group.

Table 4-1: SUS Score

System Usability Scale (SUS)	Score
EHR Application Clinical Reminders	84.75

According to usability.gov, "[b]based on research, a SUS score above a 68 would be considered above average and anything below 68 is below average."

4.2 Discussion of Findings

4.2.1 Effectiveness

The success rate for all tasks among the 10 participants were 100% completed, with a standard deviation of 0%. This means all tasks were completed without failure, with no variation in the success rate among participants.

4.2.2 Efficiency

Task Deviations

Participants completed the tasks with the optimal steps on task identifier b.11.1, b11.2, & b11.3. Participants completed task identifier b11.4 in 5 steps, exceeding the optimal 4 steps.

Task Time

Participants completed the tasks faster than the optimal time, which may indicate over performance or shortcuts. This potentially can include participants copying and pasting on task identifier b11.4. In addition, participants had variability completing the tasks but performed consistently.

4.2.3 Satisfaction

Participants followed a task satisfaction rating of 0- cannot complete the task, 1-completed with difficulty and 2-completed easily. 100% of participants rated a 2 on task identifiers b11.1 & b11.3. While 90% of participants rated a 2 on task identifiers b11.2 & b11.4. This means that there was one participant from task identifier b11.2 & b11.4 who did not rate it as a 2. Overall the System Usability Scale (SUS) score was 84.75, which concludes the system satisfaction being above average.

The task errors and task errors standard deviation were 0% on task identifiers b11.1, b11.2 & b11.3. For task identifiers b11.4 the task error was 0.8% and the task error standard deviation was 1.03%. This means that task b11.4 had more errors than the other tasks.

These task ratings were converted to a Likert scale ranging from 1 to 5, where 1 represents “difficult to complete” and “highly dissatisfied,” while 5 represents “very easy to complete,” “highly satisfied,” and “high quality.” Task identifiers b11.1 and b11.3 received a perfect score of 5, indicating that all participants rated these tasks at the highest level. Task identifiers b11.2 and b11.4 received an average score of 4.80, indicating that at least one participant rated these tasks below a 5.

4.2.4 Major Findings & Areas for Improvement

4.2.4.1 New Features & EHR Application

4.2.4.1.1 Major Findings

- The new features consist of users accessing the Source Attribute and Clinical Reminder Feedback by right-clicking a Clinical Reminder then Reference Information. This can be accessed in the RPMS EHR Application.

- The majority of the sites tested did not have text next to the clock icon in the application. This made it slightly more difficult for users to find the Clinical Reminders in the task. Another finding was that users did not know they could right-click a Clinical Reminder. A user also did not like the additional steps taken to access these new options.

4.2.4.1.2 Areas for Improvement

- Include the text “Clinical Reminders” next to the clock icon for all sites. This will help users understand the purpose of the clock icon.

- Reduce the number of steps required to access the Source Attributes and Clinical Reminder Form when right-clicking on a Clinical Reminder. This can be done by modifying the right-click options and removing the Reference Information. Change the ordered list and naming to the following: Clinical Maintenance, Reminder Inquiry, Education Topic Definition, More Reminder Details, National Reminder Feedback, Evaluate Reminder, Reminder Icon Legend. This was the sequence based on user feedback and priority sequence.

- Make it clear to the user that they can access additional options by right-clicking a Clinical Reminder. This can be done by including an icon and text that can help users recognize the right-click functionality exists on a Clinical Reminder. Users are aware of the double click functionality.

4.2.4.2 New Features & Webpages

4.2.4.2.1 Major Findings

- In one feature, users can access a Source Attribute webpage, which contains links to documents with additional Clinical Reminder source information. In the other feature, users can choose Clinical Reminder Feedback to submit feedback on national Clinical Reminders.

- Users had trouble understanding the titles and meaning of the webpages Source Attribute and Decision Support Intervention (Reminders) Feedback. Users also did not know what information to expect from the name alone with no description.

4.2.4.2.2 Areas for Improvement

- Change the title of the webpage “Source Attribute” to “Additional Source Details for VA Clinical Reminders (PXRM),” change “Decision Support Intervention (Reminders) Feedback” to “Provide National Feedback for VA Clinical Reminders (PXRM).”

- It is also important to provide additional details on the Source Attribute webpage to help users understand the purpose of the page. Also, including the date of publication or last updated for each source document provided.

4.2.4.3 Source Attributes Documents

4.2.4.3.1 Major Findings

- Users had difficulty understanding the order structure of the Clinical Reminders in the document Evidence Based Decision Support Intervention Source Attributes. Users could not tell if the document was organized alphabetically or by year. Users disliked document structure with too much information being shown at once. A user mentioned that a Clinical Reminder was missing source information, since there was an empty clinical reminder with no source.

4.2.4.3.2 Areas for Improvement

- Categorize the sources alphabetically as a priority, followed by year.
- Include a table of contents to find sources efficiently. Incorporate different heading sizes to help distinguish between sources and information. Integrate page numbers on each page and left-align all content.
- Add source information on Clinical Reminders that did not have any information directly below. Include age details on the reminders since all reminders don't have any specific details on age.

4.2.4.4 Clinical Reminders Form Messaging & Structure

4.2.4.4.1 Major Findings

- Users can access this form in the EHR application by right-clicking a Clinical Reminder, followed by Reference Information and Clinical Reminder Feedback. Users had trouble understanding the purpose of the form and certain options in the form.
- The title of the form, Decision Support Intervention (Reminders) Feedback, could be iterated to provide more meaning to the user. Users also had trouble comprehending the important message, "Important: the form is not intended for troubleshooting local clinical site issues. Those issues should be reported locally." It was not clear to the user when this form should be filled out in local sites. Users also had difficulty knowing that the form was successfully submitted because of the red font text.

4.2.4.4.2 Areas for Improvement

- Change the title to "Provide National Feedback for VA Clinical Reminders (PXRM)."
- The Important Message should be reworded to state, "Local sites experiencing issues please contact your Clinical Application Coordinator (CAC). This form is intended for feedback on National clinical reminders only."

- Move the Category option to top of the form and do not default it to “General Comment.” Increase spacing in between each option and make it responsive for smaller screens. Moving it to the top of the form can help users understand the purpose of this form almost immediately.

- Change the success state when users successfully submit the form, “Your feedback has been submitted! An Email has been sent by this system to notify the proper individuals and a copy was sent to the Email address you registered with this Feedback item,” color from red to green.

4.2.4.5 Form Functionality & Clarity

4.2.4.5.1 Major Findings

- The form could also use changes on text fields to help users understand and fill the form more efficiently. Users would prefer an auto-populated feature to help recognize the clinical reminder name and prevent errors. Users were also not sure when they would get a response after successfully filling out the form. Users were also concerned about users mistakenly including Personally Identifiable Information (PII) in the attachments.

4.2.4.5.2 Areas for Improvement

- Auto-populate the text field, “Name of Reminder,” to help the user recognize and specify the reminder name.

- Include time frames for Priority options, Routine and Urgent. This can include days, weeks, or months).

- Include text below the “Attachments” option, “Do not include Personal Identifiable Information (PII) in this form.”

4.2.4.6 Application Text Field Option

4.2.4.6.1 Major Findings

- Users were confused and could not understand if the Application dropdown was interactive or not. The current user design is gray and is supposed to be non-interactive in a disabled state. Users would hover over the option to verify if the option is interactive. Users should not have to spend time verifying if a disabled state is interactive.

4.2.4.6.2 Areas for Improvement

- Change the text field, “Application,” to not a required field. Remove the chevron arrows on the right side of the text field. Decreasing the opacity or making the field gray compared to the interactive text fields. Another option is to remove the field and include the application name in the description in the form.

4.2.4.7 Actions Taken on Reminder

4.2.4.7.1 Major Findings

- Users were confused about the text field options in, “Actions Taken on Reminder,” and did not find it useful. Users could not comprehend the difference between “Acknowledged the Reminder” and “Used the Reminder.” Users thought that they had the same meaning. Also, users were conflicted on the meaning between “Skipped the Reminder” and “Did Not Understand the Reminder.”

4.2.4.7.2 Areas for Improvement

- Reword options on “Actions Taken on Reminder” and remove it being defaulted to “Acknowledged the Reminder.”
    - “Acknowledged the Reminder” to “Evaluated the Reminder.”
    - Remove “Skipped the Reminder.”

5.0 Test Participant Data

Table 5-1: Test Participant Data

TP Identifier	Gender	Age	Education	Computer Experience	Occupation/Role	Professional Experience (months)	Participant Computer Experience (months)	Experience with EHR (months)
TP1-b11	Female	40-49	Bachelor's Degree	Advanced	Program Analyst	96	360	192
TP2-b11	Male	40-49	Doctorate Degree	Advanced	Clinical Informaticist	44	420	172
TP3-b11	Female	50-59	Master's Degree	Intermediate	Director of Nursing	35	132	132
TP4-b11	Male	40-49	Doctorate Degree	Advanced	Clinical Informaticist	56	420	123
TP5-b11	Male	40-49	Doctorate Degree	Advanced	Pharmacy Informaticist	15	480	242
TP6-b11	Male	50-59	Doctorate Degree	Intermediate	Clinical Informaticist Consultant	120	240	241
TP7-b11	Unknown	40-49	Doctorate Degree	Advanced	Clinical Informaticist	73	600	192
TP8-b11	Male	30-39	Doctorate Degree	Intermediate	Clinical Informaticist	72	336	131
TP9-b11	Male	30-39	Doctorate Degree	Advanced	Clinical Pharmacist	48	312	48
TP10-b11	Female	40-49	Doctorate Degree	Intermediate	Clinical Application Coordinator	108	160	108

Acronym List

Acronym	Term Meaning
CAC	Clinical Application Coordinator
DSI	Decision Support Intervention
HTI-1	Health Data, Technology, and Interoperability
IHS	Indian Health Service
NIST	National Institute of Standards and Technology
NISTIR 7741	Processes Approach for Improving the Usability of Electronic Health Records
NISTIR 7742	Customized Common Industry Format Template for Electronic Health Record Usability Testing
PII	Personal Identifiable Information
PXRM	VA Clinical Reminders
RPMS	Resource and Patient Management System
SUS	System Usability Scale
UCD	User-Centered Design

IHS RESOURCE AND PATIENT MANAGEMENT SYSTEM

Health Information Technology Systems and Support

Summative Usability Testing

Report

Version 1.0
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Office of Information Technology
Division of Information Technology

Table of Contents

Preface

This document presents the Summative Usability Testing for §170.315 (a)(5) Patient Demographics and Observations for the IHS Resource and Patient Management System (RPMS) Electronic Health Record (BCER v9.0) Business Patient Registration Module (BPRM v4.0 p6) application.

1.0 Executive Summary

From September 9, 2025, through October 3, 2025, a summative usability test of the Business Patient Registration Module (BPRM v4.0 p6) component of the IHS Resource and Patient Management System Electronic Health Record (BCER v9.0) was conducted. The test evaluated the following sections of BPRM v4.0 p6 application with the new feature enhancements: Demographics, Address/Email/Internet, Address History, Tribe & Eligibility Status, Legal Name, Family Information, Insurance Information, and Death Information.

This test aimed to validate the User-Centered Design (UCD) of these updates in alignment with the Health Data, Technology, and Interoperability: Certification Program Updates, Algorithm Transparency, and Information Sharing (HTI-1) final rule requirements, which emphasize certification, transparency, and safety. Results demonstrate that the EHR's updated features meet UCD best practices, addressing both §170.315(g)(3) Safety-enhanced design and §170.315(a)(5) Patient Demographics and Observations certification criteria. The UCD is functional, accessible and intuitive.

The intended users for this application include administrative and management staff within IHS who perform, manage, or monitor patient related workflows. This study collected performance data tasks identified by the project team and involved participants matching the target user criteria.

During the approximately 80-minute one-on-one usability test sessions, each participant was greeted by the administrator who introduced the test. The participant logged in to the application to complete a series of tasks (given one at a time) using the application.

During each test session, the administrator timed the test and recorded user performance data. Participant screens and audio were also recorded for subsequent analysis.

The following types of data were collected for each participant:

- Demographic data
- Number of tasks successfully completed
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system

All participant data was de-identified so that no correspondence could be made from the identity of the participant to the data collected.

The test method and metrics were based on the National Institute of Standards and Technology (NIST) Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)[i]. The NISTIR 7741 provides a detailed set of guidelines to improve the usability, safety, and effectiveness of EHR systems. These guidelines focus on human-centered design principles to enhance user interaction, reduce errors, and optimize workflow efficiency in clinical environments. This report outlines best practices, usability evaluation methods, and design principles to ensure EHRs support healthcare providers effectively while improving patient care.

Following the conclusion of the test, participants were asked to complete a post-test questionnaire and were thanked for their participation.

The Task Satisfaction Rating is based on the following pre-defined scale:

- 0 – The tester is unable to complete the task.
- 1 – The tester is able to complete the task with some difficulty.
- 2 – The tester is able to complete the task easily.

1.1 Major Findings

Through the process of testing, the users found the new features implemented in BPRM v4.0 p6 to be easy to access and convenient to navigate. However, in some cases, the purpose and/or process was not completely clear to users. Additionally, the meaning of the error messages were not always clear to the participants. The user experience could be improved by making modifications to the design elements.

Table 1-1 contains the primary issues that the participants encountered during each task. See Section 4.2.4 for detailed information related to these findings.

Table 1-1: Major Findings

Task Identifier	Task Description	Issue
a5.1	Edit the Demographics	Participants were confused by the similarities between the “Occupation”, “Occupation Industry”,

[i] National Institute of Standards and Technology, *NISTIR 7741: Usability Guidelines for Electronic Health Records (EHRs)*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7741-nist-guide-processes-approach-improving-usability-electronic-health-records

Task Identifier	Task Description	Issue
		and “Employer” text fields, and felt overwhelmed with the dropdown menu options.
a5.2	Edit a United States Address	Participants misused the auto-populated ZIP code feature because the suggested menu with the ZIP codes would not appear immediately, causing them to skip the field, leave it blank, or re-enter the ZIP code. They also did not understand the purpose of the “Date Lived From” and “Date Lived To” text fields.
a5.3	Edit a Canada Address	Participants could not easily access the menu option “Canada” in the “State text field” and had difficulty using the keyboard navigation.
a5.4	Edit Address History	Participants did not understand the purpose of the address history and assumed it would provide more meaningful or actionable information. Some participants also questioned how the address verification was performed.
a5.5	Edit Tribe & Eligibility Status	Participants varied in their understanding of eligibility, tribal membership, and blood quantum requirements.
a5.6	Edit Legal Name	One participant was unable to enter the name in the correct format due to unclear system feedback.
a5.7	Edit Family Information	Several participants could not easily locate the Parent/Guardian text fields and one participant could not save the form due to hidden required fields.
a5.8	Edit Insurance Information & Add Policy Member	Participants misunderstood this two-step process of adding a policy member and saving the form.
a5.9	Discharge Patient in ADT & Edit Death Information	Participants struggled to locate the discharged patient due to navigation inconsistencies. They often forgot which demo patient was selected.

Table 1-2: Criteria Success and Satisfaction Rating Summary

Tasks	Task Success	Task Satisfaction Rating (Scale 0-2)
	Mean %	% Rated 2 – Completed Easily
a5.1 - Edit the Demographics	100%	90%
a5.2 - Edit a United States Address	100%	80%
a5.3 - Edit a Canada Address	100%	90%
a5.4 - Edit Address History	90%	80%
a5.5 - Edit Tribe & Eligibility Status	100%	90%
a5.6 - Edit Legal Name	90%	90%
a5.7 - Edit Family Information	90%	90%
a5.8 - Edit Insurance Information & Add Policy Member	100%	90%
a5.9 - Discharge a Patient in ADT & Edit Death Information	80%	30%

1.2 Recommendations

Summative usability testing of the selected BPRM functions revealed several opportunities to improve the user experience, in terms of effectiveness, efficiency, and satisfaction. This section highlights those improvements. See Section 4.2.4 for a detailed discussion of the findings and the recommendations that they engendered. A summary of the recommendations is presented here:

- Enable search within text fields
- Establish relationships among related fields (e.g., minimize options in the Occupation Industry based on the chosen Occupation)
- Provide instructions and/or descriptions of expected content for fields (e.g., add supporting text for the “Date Lived From” field)
- Allow users to hide fields that contain sensitive information.
- Increase visibility of buttons
- Increase visual distinction across columns of information and across sections
- Improve instructions to users
- Visibly display error message banners

- Provide explanatory text to improve user comprehension of the purpose of each section
- Improve and clarify the complex workflows
- Refine error messaging and recovery to provide real-time error feedback and guidance on resolution.
- Improve text of error messages to increase users' understanding of the error and resolution.
- Simplify options for form fields and clarify the labels
- Improve section readability by enlarging headings and spacing to increase user interface contrast and accessibility.
- Use colors to help distinguish sections

General recommendations for future development suggest that usability activities continue to be part of the development process for projects and/or products that involve user interfaces, and that usability lessons learned continue to be documented for potential future improvements.

2.0 Introduction

The Health Data, Technology, and Interoperability (HTI-1) final rule introduces updates to certification, algorithm transparency, and information sharing, requiring §170.315(g)(3) Safety-enhanced design to implement user-centered design and conduct summative usability testing on the newly implemented features for §170.315(a)(5) Patient Demographics and Observations criteria. These features include the Demographics, Address/Email/Internet, Address History, Tribe & Eligibility Status, Legal Name, Family Information, Insurance Information, and Death Information sections.

In addition, the summative usability test report follows the National Institute of Standards and Technology (NIST) Customized Common Industry Format Template for Electronic Health Record Usability Testing (NISTIR 7742)[ii]. Summative usability testing is a task-based evaluation that measures the ease of use of a completed product. The results are analyzed and compared to the usability requirements to determine if those requirements have been met.

2.1 Purpose

The purpose of this test is to evaluate and validate the usability of the newly implemented enhancements to the Business Patient Registration module (BPRM v4.0 p6) application, as well as identify any areas of improvement.

2.2 Scope

The scope of usability testing is limited to testing user-involved tasks. Automated tasks and tasks without user interaction are not covered in this test. Functional testing is not covered in detail. Functionality is only tested as it pertains to the usability of the product or feature being tested.

[ii] National Institute of Standards and Technology, *NISTIR 7742: Customized Common Industry Format Template for Electronic Health Record Usability Testing*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7742-customized-common-industry-format-template-electronic-health-record

3.0 Method

The test method and metrics were based on the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)[iii].

The objective of this test was to uncover areas where the application performed well and areas where the application failed to meet the usability needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same application capability and/or comparison with other application capabilities provided the same tasks are used. This testing serves as both a means to record or benchmark current usability and to identify areas where improvements must be made.

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

- Number of tasks successfully completed.
- Time to complete the tasks.
- Number and types of errors.
- Path deviations.
- Participant's verbalizations (comments).
- Participant's satisfaction ratings of the system (Task Satisfaction Rating).
    - 0 – Could not complete the task.
    - 1 – Completed the task with some difficulty.
    - 2 – Completed the task easily.

3.1 Roles and Responsibilities

Table 3-1: Roles and Responsibilities

Role/Function	Responsibilities
Project Manager/Criteria Owner	• Responsible for the management, monitoring, and tracking of the project and oversees all areas.
Usability Test Lead / Test Administrator	• Ensures that usability testing is conducted successfully and meets all usability testing deadlines. • Provides application systems analysis for application testing activities. • Prepares required documentation at the program level for testing activities.

[iii] National Institute of Standards and Technology, *NISTIR 7741: Usability Guidelines for Electronic Health Records (EHRs)*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7741-nist-guide-processes-approach-improving-usability-electronic-health-records

Role/Function	Responsibilities
	• Monitors and escalates risks or concerns about achieving goals or meeting schedules to program leadership. • Prepares all testing instructions, scripts, and materials for use in the testing session. • Performs analysis of testing results, prepares and delivers test report. • Moderates the test. • Collects test data.
Test Participants	• Complete the assigned tasks. • Provide honest feedback on their experience.

3.1.1 Test Participants

10 end users participated in this round of testing; they were:

- Typical end-users.
- Trained to use the application prior to usability testing.
- Recruited by g(3) Safety-enhanced design team.
- Not compensated for participation.
- Assigned a participant ID at random.

Once participants were identified, they were scheduled for 80-minute one-on-one web conferencing sessions. A calendar was used to keep track of the participants' scheduled sessions, while their location (site) and contact information was documented.

3.2 Test Location

The test was conducted remotely via the use of video conferencing and desktop sharing software (Microsoft Teams).

3.3 Test Environment

The test participants were physically located at their normal duty stations, logged into their assigned workstations, and connected to the video conferencing software. The test administrator worked from a separate location and was connected via video conferencing software.
The test participants shared their screen during testing. The response time was considered to be representative of what actual users would experience in a field implementation.

3.4 Test Tools

Before and after the usability test, various forms were used, including:

- Demographic & Application Survey
- Moderator's Guide
- Post-test Questionnaire

Video conferencing software was used to connect participants with the administrator. This software was also used to record the video and audio of test sessions.

3.5 Task Scenarios

The testing and step by step tasks were constructed to represent the kinds of activities a user would perform using the capabilities being tested. Tasks were chosen with the test objectives in mind to ensure that participants provided the most meaningful data possible. The tasks were arranged to facilitate a typical end-user workflow. These tasks encompass newly implemented features that need certification testing for HTI-1. Given the recent updates to the user interface and user experience, these tasks are expected to effectively evaluate functionality and performance with participants.
Each participant was assigned a random demo patient and asked to find and use random demo patients throughout the tasks. The moderated testing scenarios and associated tasks are included in Table 3-2:

Table 3-2: Testing Scenarios

Task ID	Task Name	Testing Scenarios
a5.1	Edit the Demographics	• Edit the Demographic section by modifying the following information and fields: Date of Birth, Birth Sex, Occupation/Occupation Industry, Ethnicity, Race, Primary Language, Preferred Language, and English Proficiency. • Navigate to the bottom to "Save" their information.
a5.2	Edit a United States Address	• Edit the Address/Email/Internet section to modify the following information and fields: Street Address, ZIP Code, City, State, Rx Patient Residence, Date Moved [Community], and Current Community. • Navigate to the bottom to "Save" entered information. • Select the Address Entered from the displayed Address Verification dialog and click on "Use Selected Address".
a5.3	Edit a Canada Address	• Complete the same steps as the U.S Address, but with a Canada address. • Navigate to the bottom and click "Save". Completing this task replaces the current address and moves the U.S address to the address history section.

Task ID	Task Name	Testing Scenarios
a5.4	Edit Address History	• Edit the previously input U.S address (4321 Mesa View Drive NE). • Select “Suggested Address”, input “Date Lived From” and “Date Lived To” and “Save” to verify the address.
a5.5	Edit Tribe & Eligibility Status	• Modify the following information and fields: "Eligibility Status”, “Classification/Beneficiary”, “Tribe of Membership”, “Indian Blood Quantum”. • Navigate to the bottom to “Save”.
a5.6	Edit Legal Name	• Edit the assigned demo patient's legal name by modifying the “Name”, selecting “Proof Provided”, and clicking the “Save” button.
a5.7	Edit Family Information	• Add a Parent/Guardian by modifying the “Name”, “Relationship”, and “Primary Phone. • Navigate to the bottom and click “Save”.
a5.8	Edit Insurance Information & Add Policy Member	• Modify the demo patient’s insurance by reading out loud the status of the insurer and editing that insurer. The participant modifies the following information and fields: “Policy Number or SSN”, “Group Name/Number”, and “Coverage Type”. • Add a policy member on that same insurer by editing “Policy Member”, “Relationship”, “State Date” and clicking “OK” in the dialog box that appears. • Upon return to the insurer screen, navigate to the bottom and click “Save”.
a5.9	Discharge a Patient in ADT & Edit Death Information	• In the “ADT” section, select a Ward checkbox, which displays a list of patients on the right. • Right-click on a random demo patient and select “Discharge Patient”. Note: the selected demo patient for a later task. • Modify the following information and fields: “Discharge Date”, “Discharge Time”, “Type of Discharge”, and “Discharge Status”. Click ”Save”. • Search for the discharged demo patient and modify that patient’s death information. • Modify the “Preliminary Cause of Death” and “Date of Death” then click “Save”.

3.6 Procedure

Upon arrival, each participant was greeted by the administrator and matched to a name on the participant schedule. The test administrator moderated the test session, which included administering instructions and tasks. The administrator also monitored task times, obtained post-task rating data, and took notes on participant comments.
Each participant was instructed to perform the tasks:

- As quickly as possible, making as few errors and deviations as possible.

- Without assistance. Administrators were allowed to give immaterial guidance and clarification on tasks, but not instructions on use.

All participants used the same version of the software. After the first session, the task instructions were revised to improve user understanding:

- Task a5.1 *Edit the Demographics*, called for participants to modify the date of birth. The instructions text was changed from “Subtract a year from the birth year” to “Change the patient’s birth year to be one year earlier”.
- In task a5.9 *Discharge Patient in ADT & Edit Death Information*, the instructions for “Discharge Date” were changed from “Enter Today’s Date” to “Change to 07-08-2025”. This ensured that the discharge date matches the date of death.

The test participant logged into the test environment. After login, the user was instructed to complete a series of tasks (given one at a time) using the application. The task instructions were sent through the Microsoft Teams meeting chat.

The administrator ensured the participants understood the task before proceeding with the task. Task timing began once the participant acknowledged readiness and proceeded with the task. The task time was stopped once the participant indicated that the task was completed.

Scoring is discussed in Section 3.7, Usability Metrics.

After completion of the testing tasks, the administrator gave the participant a post-test questionnaire (System Usability Scale, or SUS), asked if they had any questions, and thanked them for their participation.

Each participant’s demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire ratings were recorded into the participant spreadsheet.

Following each test session, the video recordings were reviewed and checked against the data logged in the participant spreadsheet. The participant spreadsheet was updated with any edits or additional information such as verbalizations.

3.7 Usability Metrics

According to the NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)[iv], EHRs and supporting applications should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction. To this end, metrics for effectiveness, efficiency, and user satisfaction were captured during the usability testing.
The goals of the test were to assess the following:

- Effectiveness by measuring participant success rates and errors.
- Efficiency by measuring the average task time and path deviations.
- Satisfaction by measuring task satisfaction ratings and SUS scores.

3.7.1 Data Scoring

Table 3-3 details how tasks were scored, errors evaluated, and the time data analyzed.

Table 3-3: Data Scoring Methodology

Measures	Rationale and Scoring
Effectiveness: Task Success	• A task was counted as a "Success" if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis. • The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage. • Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency. • Optimal task performance time, as benchmarked by expert performance under realistic conditions, is recorded when constructing tasks. Target task times used for task times in the Moderator's Guide must be operationally defined by taking multiple measures of optimal performance and multiplying by some factor [e.g., 1.25] that allows some time buffer because the participants are presumably not trained to expert performance. Thus, if expert, optimal performance on a task was [x] seconds then allotted task time performance was [x * 1.25] seconds. This ratio should be aggregated across tasks and reported with mean and variance scores.

[iv] National Institute of Standards and Technology, *NISTIR 7741: Usability Guidelines for Electronic Health Records (EHRs)*, 2010. [Online]. Available: https://www.nist.gov/publications/nistir-7741-nist-guide-processes-approach-improving-usability-electronic-health-records

Measures	Rationale and Scoring
Effectiveness: Task Failures	• If the participant abandoned the task, did not reach the correct answer or performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as a "Failure." No task times were taken for errors. • The total number of errors was calculated for each task and then divided by the total number of times that task was attempted. Not all deviations would be counted as errors. This should also be expressed as the mean number of failed tasks per participant. • On a qualitative level, an enumeration of errors and error types should be collected.
Efficiency: Task Deviations	• The participant's path (i.e., steps) through the application was recorded. Deviations occurred if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation.
Efficiency: Task Time	• The workflow was timed from the moment the participant said "begin" until they said "done." If the participant failed to say "done," timing ceased when they stopped performing the tasks. Only workflows that were successfully completed were included in the time analysis. The average time for the workflow was calculated, along with variance measures, including standard deviation and standard error.
Satisfaction: Task Satisfaction Rating	• User satisfaction is rated using the Task Satisfaction Rating. • Performance Standard: 80% of tested users complete the testing tasks, as specified by the customer, easily during summative usability testing, using the following scale: 0 – Unable to complete the task. 1 – Completed the task with some difficulty. 2 – Completed the task easily. • To measure participants' confidence in the system and its overall likeability, the testing team administered the System Usability Scale post-test questionnaire. Questions included, "I think I would like to use this system frequently," "I thought the system was easy to use," and "I would imagine that most people would learn to use this system very quickly."

4.0 Results

4.1 Data Analysis and Reporting

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above.

4.1.1 Effectiveness, Efficiency & Satisfaction Data

Table 4-1: Effectiveness

Task Identifier	Task Description	# Participants	Success Rate	Standard Deviation
a5.1	Edit the Demographics	10	100%	0%
a5.2	Edit a United States Address	10	100%	0%
a5.3	Edit a Canada Address	10	100%	0%
a5.4	Edit Address History	10	90%	31.62%
a5.5	Edit Tribe & Eligibility Status	10	100%	0%
a5.6	Edit Legal Name	10	90%	31.62%
a5.7	Edit Family Information	10	90%	31.62%
a5.8	Edit Insurance Information & Add Policy Member	10	100%	0%

Task Identifier	Task Description	# Participants	Success Rate	Standard Deviation
a5.9	Discharge Patient in ADT & Edit Death Information	10	80%	42.16%

Table 4-2: Task Satisfaction Rating (0-Cannot complete task, 1-Completed with difficulty, 2-Completed easily)

Task Identifier	Task	% Rated 2-Completed Easily
a5.1	Edit the Demographics	90%
a5.2	Edit a United States Address	80%
a5.3	Edit a Canada Address	90%
a5.4	Edit Address History	80%
a5.5	Edit Tribe & Eligibility Status	90%
a5.6	Edit Legal Name	90%
a5.7	Edit Family Information	90%
a5.8	Edit the Insurance Information & Add Policy Member	90%
a5.9	Discharge Patient in ADT & Edit Death Information	30%

Table 4-3: Efficiency

Task Identifier	Task Description	Ob-served # Steps	Optimal # Steps	Task Time Mean (seconds)	Task Time Std Dev (seconds)	Task Time Deviation Observed (seconds)	Task Time Deviation Optimal (seconds)	Task Errors Mean	Task Errors Std Dev
a5.1	Edit the Demographics	5	3	155	32	28	76	20%	42.16%
a5.2	Edit a United States Address	5	4	117	58	45	62	50%	52.70%
a5.3	Edit a Canada Address	4	3	86	37	26	52	10%	31.62%
a5.4	Edit Address History	4	3	78	71	40	34	0%	0%
a5.5	Edit Tribe & Eligibility Status	5	3	70	55	40	39	10%	31.62%
a5.6	Edit Legal Name	2	2	51	65	37	64	10%	31.62%
a5.7	Edit Family Information	3	3	68	57	38	43	0%	0%
a5.8	Edit Insurance Information & Add Policy Member	7	6	150	95	69	80	0%	0%
a5.9	Discharge Patient in ADT & Edit Death Information	10	8	271	117	98	153	10%	31.62%

Table 4-4: Task Satisfaction - Likert

Task Identifier	Task Description	Task Rating-Scale Type	Task Ratings Mean	Task Ratings Std Dev
a5.1	Edit the Demographics	Likert	4.80	0.63
a5.2	Edit a United States Address	Likert	4.60	0.84
a5.3	Edit a Canada Address	Likert	4.80	0.63
a5.4	Edit Address History	Likert	4.40	1.35
a5.5	Edit Tribe & Eligibility Status	Likert	4.80	0.63
a5.6	Edit Legal Name	Likert	4.60	1.26
a5.7	Edit Family Information	Likert	4.60	1.26
a5.8	Edit Insurance Information & Add Policy Member	Likert	4.80	0.63
a5.9	Discharge Patient in ADT & Edit Death Information	Likert	3.20	1.48

4.1.1.1 System Usability Scale (SUS)

The results of the System Usability Scale (SUS) from the post-test questionnaire show subjective satisfaction with the application by the participants. The overall SUS score for the BPRM v4.0 p6 application, based on this Summative Usability Testing, is 98.5.

Table 4-5: SUS Score

System Usability Scale (SUS)	Score
BPRM Application	98.5%

According to usability.gov, "[b]ased on research, a SUS score above a 68 would be considered above average and anything below 68 is below average."

4.2 Discussion of Findings

4.2.1 Effectiveness

The success rate of tasks varied; more than half of these tasks were completed successfully Refer to Table 4-1 for the statistics related to Effectiveness.

- Five tasks had a success rate at (100%) (standard deviation of 0%). This means those tasks were completed without failure, with no variation in the success rate among participants.
- Three tasks had a (90%) success rate (standard deviation of 31.62%). The reasons behind these results include:
    - One participant was not able to complete task a5.4 *Edit Address History* due to previous error inputs from task a5.2 *Edit a United States Address*.
    - Two participants thought the instructions were unclear and did not know how to recover from an error on tasks a5.4 *Edit Address History* and a5.6 *Edit Legal Name.*
    - An error message was not visible to one participant on task a5.7 *Edit Family Information*.
    - These issues highlight gaps in clarity in the instructions and around error recovery, and visibility of system feedback.
- One task had the lowest success rate at (80%) and highest variability (standard deviation of 42.16%):

- Two participants were not able to complete the task because the application did not display the required interface elements. This issue was caused by system constraints related to older demo patients with outdated medical record numbers within the application.
- One participant didn't save the form when discharging a demo patient which prevented the participant from seeing the required interface elements.

Overall, this task process was the most difficult to understand due to its complex user flow.

4.2.2 Efficiency

The efficiency rating varied among the nine tasks. Refer to Table 4-2 for the statistics related to Efficiency.

4.2.2.1 Task Deviations

Participants completed the task with the optimal steps on two tasks. This means that the participants completed the tasks efficiently with the most correct sequence of steps needed to complete a task.

On four tasks, participants exceeded the optimal number of paths by one task path deviation. This implies that participants made one variable navigation or action beyond the ideal route, suggesting minor inefficiencies within the interface.

For three tasks, participants exceeded the optimal number of paths by two task path deviations. This indicates that participants made two additional variable navigation or actions beyond the most efficient workflow. This suggests that there are minor usability inefficiencies or interface clarity issues within these areas of the application and user flow.

4.2.2.2 Task Time

Participants completed seven tasks faster than the optimal time, which may indicate familiarity of the application or shortcuts.

Participants took longer than the optimal time for two tasks, once by six seconds and once by one second. Possible explanations include:

- For task a5.4 *Edit Address History*, this could be due to the "Suggested Address" option not being visible in the interface to participants who did not successfully complete the previous task a5.2.

- For task a5.5 *Edit Tribe & Eligibility Status*, this may have occurred because participants were not able to save the form due to the "Tribal Quantum" text field dependency. If the "Tribal Quantum" text field is filled and there are modifications to the "Indian Blood Quantum", then the "Tribal Quantum" text field needs to be adjusted. Neither the test instructions nor the application provided guidance on how to recover from this system-related issue, which contributed to participants taking longer than the optimal time for both of these tasks.

The overall efficiency results were positive and can be improved by implementing clearer text field labels, supporting instructional text and guiding functionality (Discussed in section 4.2.4). These enhancements will reduce the amount of steps and of time spent on tasks a5.2 *Edit a United States Address*, a5.4 *Edit Address History* and a5.*5 Edit tribe and Eligibility Status*.

4.2.3 Satisfaction

The efficiency rating varied among the nine tasks. Refer to Table 4-2 for the statistics related to Satisfaction.

Participants followed a task satisfaction rating of 0 (cannot complete the task), 1 (completed with difficulty), and 2 (completed easily).

For six tasks, 90% of participants rated their satisfaction as a 2 (completed easily).

For two tasks, 80% of participants rated their satisfaction as a 2 (completed easily).

For one task, only 30% of participants rated that task as a 2 (completed easily). This task also had the lowest completion rate and participants took more steps to complete this task.

Overall the System Usability Scale (SUS) score was 98.50, which indicates that the system satisfaction was above average, and the application is perceived as highly usable and intuitive. While participants had difficulties completing certain tasks, they still felt the overall system was clear and logical.

4.2.3.1 Task Error

Refer to Table 4-3 for details on the data summarized here.

The task errors and task errors standard deviation were 0% on task identifiers a5.4, a5.7, and a5.8. For task identifiers a5.3, a5.5, a5.6, and a5.9, the task error was 10% and the task error standard deviation was 31.62%. For task identifier a5.1, the task error mean was 20% with a 42.16% task error standard deviation. For task identifier a5.2, task error mean was 50% with a 52.70% task error standard deviation.

4.2.3.2 Likert Scale

Refer to Table 4-4 for details on the data summarized here.

The initial task satisfaction ratings were converted to a Likert scale ranging from 1 to 5, where 1 represents “difficult to complete” and “highly dissatisfied,” while 5 represents “very easy to complete,” “highly satisfied,” and “high quality.”

Task identifiers a5.1, a5.3, a5.5, and a5.8 received an average score of 4.80. Task identifiers a5.2, a5.6, and a5.7 received an average score of 4.60. Task identifier a5.4 received an average score of 4.40. Task identifier a5.9 received an average score of 3.20.

4.2.4 Major Findings & Recommendations for Improvement

Table 4-6: Major Findings & Recommendations for Improvement

Task ID	Task Name	Findings	Recommendations
a5.1	Edit the Demographics	• Participants had difficulty distinguishing among the Occupation, Occupation Industry, and Employer text fields. • Participants felt overwhelmed with the number of dropdown menu options to choose from within the Occupation and Occupation Industry fields. This increased cognitive load and slowed down the decision-making process.	• Change the Occupation and Occupation Industry fields to free text fields so users can type and search. • Minimize options in the Occupation Industry based on the chosen Occupation. • Add a helpful description in the supporting text to clarify the differences among the “Employer”, “Occupation”, and “Occupation Industry” text fields. • Utilize colors to show the importance of this section to encourage data accuracy.
a5.2	Edit a United States Address	• Participants often misused the ZIP code auto-populate feature. For this feature to function properly, numbers must be input into the ZIP code text field in order for a list to display below the text field. If a participant did not wait long enough for that list to appear, they skipped this functionality and proceeded to the next text field. This would cause the ZIP code text field to be blank. • Participants did not understand the meaning and purpose of the “Date Lived From” and “Date Lived To” fields.	• Utilize supporting text and an interactive design to the ZIP code text field that will guide the user to choose an option from the auto-populated list. • Display the auto-populated menu immediately after the user enters the first digit. • Add supporting text for the “Date Lived From” field, including an explanation for the usefulness of this information. • Add information explaining why the user should use the selected address and how it is reflected in the “Address History”.

Task ID	Task Name	Findings	Recommendations
a5.3	Edit a Canada Address	• Participants had difficulty with the keyboard functionality in the “State” text field. • Testers attempted to look through the menu options and struggled to locate the “CANADA” menu option.	• Allow users to find “CANADA” by typing “CAN” while using the keyboard. • Include foreign countries on top of the menu options. • Add the auto-populate feature to foreign addresses.
a5.4	Edit Address History	• Participants wanted to know the source for verifying an address and assumed it followed USPS address standards. • Participants expressed a need for more privacy when revealing sensitive information when patients or staff were nearby. • Testers overlooked the “Date Lived From” and “Date Lived To” fields. • Users needed to be alerted that foreign addresses cannot be verified within the user interface.	• Implement show-and-hide functionality on sensitive information throughout the application. • During address verification, provide the logic for what determines a suggested address. • Allow the user to delete an address from the address history. • Increase the visibility of the “Verify Status” button. • Visually distinguish the columns from the address history table. • Display text that foreign addresses cannot be verified.
a5.5	Edit Tribe & Eligibility Status	• Participants showed a variety of experiences with eligibility, tribal memberships, blood quantum, and tribal enrollment numbers. While one participant did not understand the purpose of gathering this information, most had previous experience and knew the purpose and definitions. • Participants were challenged with identifying the distinction between “CHS” and “Direct Only” eligibility.	• Include dropdown menu items for the blood quantum fields. • Include an “Other” option in the recommended dropdown menu for the blood quantum fields. • Prompt the user to revisit the “Tribal Enrollment Number” text field after modifying the “Tribal Membership” and blood quantum fields. • Add text to distinguish between “CHS” and “Direct Only” eligibility.

Task ID	Task Name	Findings	Recommendations
a5.6	Edit Legal Name	• One participant did not understand the proper formatting for the name text field. The error message in the name text field does not indicate that there should be no space after the comma. This limited the ability for the participant to recover from the error.	• In the name text field, provide instruction that users cannot add a space in between the comma and the first name. • Limit the number of characters that can be entered in the “Name” field. • Allow users to make modifications to the “Name” field within one calendar day of adding a legal name.
a5.7	Edit Family Information	• Participants valued the flexibility of the Parent/Guardian text fields. • Some participants thought this section was overwhelming with text fields and no clear visual separation. This included the Father, Mother, and two Parent/Guardian sections, with over 25 text fields that could be filled by the user.	• Condense the relationship dropdown menu options. • Display an error message banner that would be visible at all times. • Separate the Father, Mother, and Parent/Guardian sections.
a5.8	Edit Insurance Information & Add Policy Member	• One participant had trouble understanding this two-step process of adding a policy member and saving the policyholder information. The tester believed they had completed the task after adding a policy member. The changes made by that participant were not applied since they did not save the form. • It was not clear to the participants who the policyholder was within the added policy members.	• Provide instructions that explain the difference between “Policy Number or SSN” and “Group Name & Number”. • Create two distinct text fields: “Policy Number” and “SSN”. • Display the policy holder information from the list of policy members. • Provide a description of the relationship and person codes. • Enforce the need to save after adding a policy member. • Improve the overall structure of the form and the process of confirming added policy members and saving the form.

Task ID	Task Name	Findings	Recommendations
a5.9	Discharge a Patient in ADT & Edit Death Information	• Participants had difficulties populating patients within Admit, Discharge, Transfer (ADT). • Some attempted to use the top navigation to populate patients instead of the left navigation to locate a demo patient. • A few participants forgot to note the name of the discharged demo patient. • Participants struggled to follow the proper steps required to complete this task.	• Provide text that describes the purpose of the ADT section. • In the “Discharge Status” dropdown, group the “Expired” options. • Provide searchable patient name functionality on the “Discharge List” located on ADT’s top navigation bar. • Reengineer this process to follow a single and intuitive flow that allows the user to enter the “Preliminary Cause of Death” and “Date of Death” after discharging a patient, without the need to do these steps independently. • Consolidate ADT and Death Information into one streamlined process that continuously displays the patient's name after discharge and allows the user to enter more details as needed. • The interface should guide users when they are discharging patients in ADT and editing their death information, instead of having to train users to memorize this workflow. This will help reduce training requirements and increase efficiency by minimizing the number of steps a user takes to complete this task.

5.0 Test Participant Data

Table 5-1: Test Participant Data

TP Identifier	Gender	Age	Education	Computer Experience	Occupation/Role	Professional Experience (months)	Participant Computer Experience (months)	Experience with EHR (months)
TP1-a5	Female	50-59	Bachelor's Degree	Advanced	Billing Technician	8	264	0
TP2-a5	Female	40-49	Some college credit, no degree	Intermediate	Supervisory Health Systems Specialist	40	432	67
TP3-a5	Female	40-49	Some college credit, no degree	Advanced	IT Specialist	180	540	120
TP4-a5	Female	40-49	Bachelor's Degree	Advanced	Patient Access Manager	1	216	96
TP5-a5	Female	50-59	Master’s Degree	Intermediate	Health Informaticist	57	360	6
TP6-a5	Female	20-29	Some college credit, no degree	Intermediate	Contact Representative	15	36	36
TP7-a5	Female	40-49	Some college credit, no degree	Intermediate	Contact Representative	24	372	96
TP8-a5	Female	60-69	Some college credit, no degree	Intermediate	Business Operations Center	156	240	156

TP Identifier	Gender	Age	Education	Computer Experience	Occupation/Role	Professional Experience (months)	Participant Computer Experience (months)	Experience with EHR (months)
TP9-a5	Female	40-49	Master's Degree	Advanced	Patient Registration SHSS	17	12	17
TP10-a5	Female	40-49	Some college credit, no degree	Advanced	Business Office Manager	70	216	36

Acronym List

Acronym	Term Meaning
ADT	Admit, Discharge, Transfer
BPRM	Business Patient Registration Module
CAC	Clinical Application Coordinator
HTI-1	Health Data, Technology, and Interoperability
IHS	Indian Health Service
NIST	National Institute of Standards and Technology
NISTIR 7741	Processes Approach for Improving the Usability of Electronic Health Records
NISTIR 7742	Customized Common Industry Format Template for Electronic Health Record Usability Testing
PII	Personally Identifiable Information
RPMS	Resource and Patient Management System
SUS	System Usability Scale
UCD	User-Centered Design
UI	User Interface
UX	User Experience