MDCare EMR/PMS Version 5.0

EHR Usability Test Report

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

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1. Executive Summary

A usability test of the MDCare EMR/PMS Version 5.0 was conducted from 08/25/2017 to 09/08/2017 by Vision Infonet Inc. All sessions took place remotely. The primary purpose of this summative usability test was to provide objective evidence that the Electronic Health Record under Test (EHRUT) user interfaces can be used in a safe, efficient, and effective manner with regard to nine prioritized certification 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 Interactions Checks
- §170.315(a)(5) Demographics
- §170.315(a)(7) Medication List
- §170.315(a)(8) Medication Allergy List
- §170.315(a)(9) Clinical Decision Support
- §170.315(a)(14) Implantable Device List

During the usability test, 10 physicians/providers and 10 nurses/medical assistants matching the target demographic criteria served as participants in the usability test. Each participant used MDCare EMR/PMS in simulated, but representative role-specific tasks.

This study collected performance data on 22 tasks typically conducted on an EHR by physicians/providers and nurses/medical assistants. The tasks are correlated to the twelve certification criteria in *45 CFR Part 170 Subpart C of the Health Information Technology: 2015 Edition Health Information Technology (Health IT) Certification Criteria, 2015 Edition Base Electronic Health Record (EHR) Definition, and ONC Health IT Certification Program Modifications*.

The remote, one-on-one usability test was 45 minutes for physicians and 30 minutes for nurses. During each usability test, the administrator greeted the participant. Each participant was read a request for informed consent/release and asked to give their verbal consent, which was recorded (see Appendix C | Recording Consent).

All participants were current users of MDCare EMR/PMS, so they had prior experience with some version of the EHR. Training videos on two relatively new features were distributed to nurse participants prior to the test. The training videos were consistent with online training provided to actual end users.

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

During each test, the participant's screens and audio were recorded electronically and the data logger recorded notes on paper and electronically. The recordings were later analyzed to determine task times and evaluate user performance.
All participant data was de-identified—no correspondence could be made from the identity of the participant to the data collected. Following the conclusion of the testing, participants were asked to complete a post-test questionnaire.

The UCD process used was based on NISTIR 7741[1] and various recommended metrics were used to evaluate the usability of the EHRUT. Use was in accordance with the examples set forth in the *NIST Guide to the Processes App*
roach for Improving the Usability of Electronic Health Records. The following quantitative data were collected for each participant:

- Number of tasks successfully completed within the allotted time without assistance
- Time to complete each task
- Number and types of errors
- Path deviations
- Participant's familiarity, ease-of-use, and satisfaction ratings of the system and its components
- System Usability Scale (SUS)

In addition, results include the following qualitative observations:

- Major findings
- Areas for improvement
- Participant's verbalizations

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

- Overall SUS for both providers and nurses: 70.13

2. Introduction

The EHR under Test (EHRUT) tested for this study was MDCare EMR/PMS 5.0, ambulatory electronic health record software. Designed to present medical information to healthcare providers in an outpatient setting for various specialties, MDCare EMR/PMS consists of a comprehensive electronic clinical system used to create, store, and retrieve patient data. Intended users of MDCare EMR/PMS are doctors, nurse practitioners, physician assistants, nurses, medical assistants, and anyone entering or accessing clinical data at an ambulatory medical practice. The usability testing attempted to represent realistic exercises and conditions that occur in a typical medical practice environment.
The purpose of this study was to test and validate the usability of the current user interface, and provide evidence of usability in the EHRUT. To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing, such as task success, time on task, and task group ratings.

3. Method Participants

A total of 20 participants were tested on MDCare EMR/PMS. Vision Infonet User Experience researchers coordinated the recruiting of participants with the administrators of healthcare organizations. The request to the administrators described end-user roles and the administrators identified matching participants. For the test purposes, end-user characteristics were identified and translated into a recruitment screener used to solicit potential participants.

Participants in the test were physicians, physician assistants, nurse practitioners, nurses, and medical assistants. All participants were current end users of MDCare EMR/PMS working in ambulatory

settings, varying in specialty, and ranging in years of experience with MDCare EMR/PMS. Users with clinical decision-making privileges were scheduled as physician/provider participants and users with non-provider care privileges were scheduled as nurse/medical assistant participants.
Participants had no direct connection to the development organization producing the MDCare EMR/PMS system. Participants were not from the testing or supplier organization. For relatively new features being tested, nurse participants were given the opportunity to have the same orientation and level of training as the actual end users would have received.

Recruited participants had a mix of backgrounds and demographic characteristics. Table 1 lists participants by characteristics, including occupation/role and product experience. Participant names were replaced with Participant IDs so that an individual's data cannot be tied back to individual identities.

Total Number and Description of Participants

The total number of participants was 20. Their descriptions are indicated in the table below

Participant Identifier	Gender	Age	Education	Occupation/Role	Professional Experience	Computer Experience	Product Experience	Assistive Technology Needs
MDC1	Male	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	26 years	240	8	No
MDC2	Female	40-49	Master's Degree	Nurse	10 years	144	7	No
MDC3	Male	60-69	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	45 years	240	6	No
MDC4	Female	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	8 years	240	5	No
MDC5	Female	50-59	Bachelor's Degree	Nurse	20 years	180	4	No
MDC6	Female	40-49	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	10 years	120	3	No
MDC7	Female	40-49	Master's Degree	Nurse	10 years	144	4	No
MDC8	Male	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	29 years	300	5	No
MDC9	Female	40-49	Bachelor's Degree	Nurse	20 years	240	5	No
MDC10	Male	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	21 years	240	6	No
MDC11	Female	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	30 years	300	3	No
MDC12	Male	40-49	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	10 years	180	4	No
MDC13	Female	50-59	Master's Degree	Nurse	20 years	240	8	No
MDC14	Male	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	21 years	240	8	No
MDC15	Male	60-69	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	40 years	360	5	No
MDC16	Female	40-49	Bachelor's Degree	Nurse	10 years	120	5	No
MDC17	Male	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	17 years	180	6	No
MDC18	Female	40-49	Bachelor's Degree	Nurse	10 years	180	6	No
MDC19	Male	50-59	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	20 years	240	6	No
MDC20	Female	40-49	Master's Degree	Nurse	6 years	120	4	No

Table 1: Participants

Twenty participants matching the demographics in the Participants section were recruited and all twenty participated in the usability test.

Physician/provider participants were scheduled for 45-minute sessions, and nurse/medical assistant participants were scheduled for 30-minute sessions. A minimum time interval of 15 minutes was scheduled between sessions for debrief by the administrator and data logger, and to reset systems to proper test conditions. A spreadsheet was used to keep track of the participant schedule and included key identification details for each participant.

4. Study Design

Overall, the objective of this test was to uncover areas where the application performed well—that is, effectively, efficiently, and with satisfaction—and areas where the application failed to meet the needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of MDCare EMR/PMS. In short, this testing serves as both a means to record or benchmark current usability and identifies areas for improvement.

During the usability test, participants interacted with MDCare EMR/PMS. Each participant was provided with the same instructions. The system was evaluated for effectiveness, efficiency and satisfaction as defined by measures collected and analyzed for each participant:

- Number of tasks successfully completed within the allotted time without assistance
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's verbalizations (comments)
- Participant's satisfaction ratings of the system

Additional information about the various measures can be found in the Usability Metrics section of this report.

5. Tasks

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might perform with this EHR. Tasks were selected based on the twelve ONC CEHRT2015 certification criteria, considering frequency of use, potential for risk to patient safety, and criticality of function. The Safety-Enhanced Design tasks for the twelve ONC CEHRT2015 certification criteria included:

Scenario 1: Clinical Decision Support	
Access and Enable CDS Interventions (a9.1)	170.315(a)(9) – Clinical Decision Support
Process a CDS Intervention (a9.2)	170.315(a)(9) – Clinical Decision Support
Locate Reference Information for a CDS Intervention (a9.3)	170.315(a)(9) – Clinical Decision Support
Scenario 2: Medication List	
Access Active Medications List (a7.1)	170.315(a)(7) - Medication List
Access Full Medications List (a7.2)	170.315(a)(7) - Medication List
Change an Existing Medication (a7.3)	170.315(a)(7) - Medication List
Scenario 3: CPOE (Computerized Physician Order Entry)	
Access Orders (a2.1 and a3.1)	170.315(a)(2) - CPOE Laboratory 170.315(a)(3) - CPOE Radiology
Record a New Radiology Order (a3.2)	170.315(a)(3) - CPOE Radiology
Record a New Laboratory Order (a2.1)	170.315(a)(2) - CPOE Laboratory
Access Medication Orders (a1.1)	170.315(a)(1) - CPOE Medications
Record and Change Medication Orders (a1.2)	170.315(a)(1) - CPOE Medications
Perform a Drug Interaction Check (a4.1)	170.315(a)(4) - Drug-drug, Drug-allergy Interaction Checks
Process a Drug-Drug, Drug-Allergy Interaction Alert (a4.2)	170.315(a)(4) - Drug-drug, Drug-allergy Interaction Checks
Scenario 4: Drug Interaction Checks	
Adjust Severity Level of Interventions - Limited Permissions (a4.3)	170.315(a)(4) - Drug-drug, Drug-allergy Interaction Checks
Scenario 5: Demographics	
Access and Record Demographics (a5.1)	170.315(a)(5) - Demographics
Change Demographics (a5.2)	170.315(a)(5) - Demographics
Scenario 6: Medication Allergy List	
Access Active Medication Allergies (a8.1)	170.315(a)(8) - Medication Allergy List
Change an Existing Medication Allergy (a8.2)	170.315(a)(8) - Medication Allergy List
Access Full Medication Allergy List (a8.4)	170.315(a)(8) - Medication Allergy List
Scenario 7: Implantable Device List	
Access Implantable Device List (a14.1)	170.315(a)(14) – Implantable Device List
Change an Existing Implantable Device (a14.2)	170.315(a)(14) – Implantable Device List
Record a New Implantable Device (a14.3)	170.315(a)(14) – Implantable Device List

6. Procedure

Upon arrival to the remote session, participants were greeted; their identity was verified and matched with a name on the participant schedule. Participants were then assigned a participant ID.

Each participant reviewed an informed consent and release form (Appendix C Volunteer, Non-Disclosure, and Video Informed Consent).

To ensure that the clinical test sessions ran smoothly, the administrator and the data logger, conducted each test session. Each has more than 5 years of experience, and each is well versed in planning and performing usability testing of EHRs.

The administrator for the clinical test sessions moderated the session which included administering instructions and tasks, as well as recording task time and participant comments on paper. The data logger recorded task success, click paths, number and type of errors, comments, and post-session ratings in an electronic data collection file. Participants were provided an introduction thanking them for participating, clarifying the purpose of the study, outlining the session and its flow, and what to expect when performing tasks.

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

1. As they would as part of their everyday activities.
2. Without assistance; asking for help as needed.
3. Without interacting with the moderator until the participant felt he/she was "done" with the task.

For each task, the participants were given access to an outline of the task. Participants were asked to indicate when they were done so it was clear when they completed the task, when they got to a point where they couldn't go any further without receiving help, or when they gave up and were not going to try anything else. If participants navigated away from the correct path to complete the task and were still attempting to perform the task after 30 seconds, the moderator would intervene and tell them the next single step in the task to get them back on the correct click path. Thirty seconds was selected based on previous test activities and the constraints of the session length. Tasks where the moderator assisted with one step and the participant successfully completed the task were considered passing with help. Task timing began once the administrator and participant acknowledged the participant knew what was being asked of him/her and the moderator gave the instruction, "you can start when you are ready." Task timing ended when the participant stated, "I'm done." After each task, any errors were discussed and clarified with the participants before moving forward.

Participants were instructed to talk aloud as they were completing the task. They were to say what they were doing and where they were clicking. For example, "I am reviewing the allergies so I am clicking the allergy icon." Participants were told that although they were talking out loud, the administrator would not interact with the participant until the participant said "Done".

The talk aloud methodology used was not meant to be the type of talk aloud protocol where the moderator interacts with probing questions during the task. Instead, because of the complexity of the

system and multiple click paths available to complete a task, the talk aloud was intended to aid data collection.

Following the session, the moderator gave the participant the post-test questionnaire (e.g., See Appendix F System Satisfaction) and thanked each individual for their participation.

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

7. Test Location

For these remote testing sessions, the moderator was at her personal office, the data-logger documented the data from her personal office, and each participant was at his/her location. WebEx and a teleconference line were used for each test session.

8. Test Environment

- The EHRUT is used in an ambulatory care facility. For remote usability test sessions, participants completed usability tasks using laptops with Microsoft Windows operating system. The participants had access to a mouse and the laptop's keyboard and track pad. All participants interacted using the keyboard and the mouse. The laptops had 15 /17-inch display with 1280 x 768 resolutions.
- The application was set up by Vision Infonet Inc. The application itself was running on a Microsoft Windows platform using a certification test system and certification database on a WAN connection. The usability test system consisted of a generic configuration aimed to provide functionality across the usability test sites. The Vision Infonet Inc EHRUT is a highly configurable system. This generic configuration is not an implementation used at customer sites.

9. Test Forms and Tools

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

- Informed Consent Form
- Moderator Guide
- Task Outline
- System Usability Scale (SUS) Questionnaire

Examples of these documents can be found in the Appendices.

Informed Consent Forms were used to inform participants about the study objectives and obtain permission to collect data; as well as to audio and video record the sessions.

The Moderator Guides were devised to conduct the sessions in an organized, efficient, and repeatable manner.

Task Outlines with details as needed served as a memory aid for participants regarding the details of the clinical scenarios.

The SUS questionnaire was used to collect system satisfaction data.

Participant interactions with the system were captured and recorded digitally with screen capture software running on the test machine.

10. Participants Instructions

The administrator read scenarios and task directions from the Usability Test Protocol to each participant.

Following the procedural instructions, participants were then given a selection of the 22 tasks to complete based on their role(s) in their healthcare organization, as follows:

- Physician/ Provider: 14 tasks
- Nurse/ Medical Assistant: 8 tasks

Tasks in the Usability Protocol are listed in Appendix E | Protocol Tasks.

11. 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:

- Effectiveness of MDCare EMR/PMS by measuring participant success rates and errors
- Efficiency of MDCare EMR/PMS by measuring the average task time and path deviations
- Satisfaction with MDCare EMR/PMS by measuring ease of use ratings.

12. Data Scoring

The table (Table 2) below details how tasks were scored, errors evaluated, and the time data analyzed.

Table 2: Details of how observed data were scored

	Rationale and Scoring

Effectiveness: Task Success	Task success was determined by assigning numeric weights for various levels of task success, as follows: • Success (without assistance) = 1.0 • Partial success = 0.5 • Failure = 0.0 A task was counted as a "Success" if the participant was able to achieve the correct outcome within the time allotted on a per task basis and a 'Partial success' if the participant was able to achieve the correct outcome with minimal assistance. A success score for each task was calculated by averaging the scores for each task. The results are provided as a percentage. Task times were recorded for successes. Observed task times divided by the optimal time for each task were calculated as a measure of optimal efficiency. Optimal task performance time, as benchmarked by expert performance under realistic conditions, was recorded when constructing tasks. Target task times were operationally derived by multiplying a benchmarked expert performance by a factor of 1.25, allowing for some time buffer. Thus, if expert, optimal performance on a task was 20 seconds then allotted task time performance was [20 * 1.25] seconds. This ratio was 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, performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as a Failure. No task times for failed tasks or tasks that exceeded the target task time were used in calculations.
	Rationale and Scoring
	The total number of errors was calculated by averaging the number of errors counted for each task. Not all deviations were counted as errors. Task failures were also expressed as the mean number of failed tasks per participant. A qualitative account of the observed errors and error types was collected.
Efficiency: Task Deviations	The participant's navigation 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. Path deviations are reported on a qualitative level for use in recommendations for improvement.

Efficiency: Task Time	Each task was timed from when the administrator said "Begin" until the participant said "Done." If the participant failed to say "Done," the time was stopped when the participant ceased performing the task. Only task times for tasks that were successfully completed and tasks that were completed at or under the target time were included in the average task time analysis. Average time per task and variance measures were calculated for each task for use in the results analysis.
Satisfaction: Task Rating	Participant's subjective impression of the ease of use of the application was measured by administering both a simple question on completion of each scenario and a post-session questionnaire. After each scenario, the participant was asked to rate "Overall, these tasks were:" on a scale of 1 (Very Difficult) to 5 (Very Easy). These data were averaged across participants. To measure participants' confidence in and likeability of MDCare EMR/PMS overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. See full System Usability Score questionnaire in Appendix F | System Usability Scale Questionnaire.

13. Results

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.

The usability testing results for MDCare EMR/PMS are detailed below. The results should be seen in light of the objectives and goals outlined in Study Design section. The data yielded actionable results that, when corrected, will yield a material, positive impact on user performance.

Criteria 170.315(a)(1) CPOE – Medications

Data Analysis and Reporting

Table 3: Computerized Physician Order Entry (CPOE) – Medications Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access Medications Orders	10	1.00	0.00	19.4	2.37	1.2	1.21	0.00	0.00
Record & Change Medication Orders	10	1.00	0.00	78.4	1.42	1.16	1.04	0.00	0.00

Table 4: CPOE (Computerized Physician Order Entry) Medications Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.7	0.64
Task Group Satisfaction Ratings (5=very easy)	3.6	0.80

Discussion of Findings

Physician/provider participants were given two CPOE—Medications tasks:

- Access Medication Orders (a1.1)
- Record and Change Medication Orders (a1.2)

Effectiveness

The success score for each of these tasks was 100%. Participants were easily able to access and change medication orders as well as record new ones.

Efficiency

All participants completed the task with either fewer steps or the same number of steps as expert users. All participants completed the task within the optimal time for each task, as suggested by expert timings.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale. Most participants were familiar with these tasks and found them straightforward and easy to complete.

Major Findings

- Generally, participants were able to navigate the medication order tasks with ease.

Areas for Improvement

- No additional areas for improvement related to effectiveness and efficiency were identified.

Criteria 170.315(a)(2) CPOE – Laboratory

Data Analysis and Reporting

Table 5: Computerized Physician Order Entry (CPOE) – Laboratory Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access Orders	10	1.00	0.00	17.0	1.34	1.2	1.21	0.00	0.00
Record a New Laboratory Order	10	1.00	0.00	58.0	3.54	1.12	1	0.00	0.00

Table 6: CPOE (Computerized Physician Order Entry) Laboratory Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.4	1.11
Task Group Satisfaction Ratings (5=very easy)	3.4	1.11

Discussion of Findings

Physician/provider participants were given two CPOE—Laboratory tasks:

- Access Orders (a2.1)
- Record a New Laboratory Order (a2.2)

Effectiveness

The success scores for each of these tasks were 100%. Participants were easily able to access lab orders and record a new lab order.

Efficiency

All participants completed the tasks with either fewer steps or the same number of steps as expert users. All participants completed the tasks within the optimal time for each task, as suggested by expert timings.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale. Most participants were familiar with these tasks and found them straightforward and easy to complete.

Major Findings

- Participants were easily able to record a new laboratory order. This task was easy to complete as the pick lists for this task were clearly defined.

Areas for Improvement

No additional areas for improvement related to effectiveness and efficiency were identified.

Criteria 170.315(a)(3) CPOE – Diagnostic Imaging

Data Analysis and Reporting

Table 7: Computerized Physician Order Entry (CPOE) – Diagnostic Imaging Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access Diagnostic Imaging Orders	10	1.00	0.00	13.7	1.80	1	1.14	0.00	0.00
Record a New Radiology Order	10	1.00	0.00	50.8	1.93	1.16	1.05	0.00	0.00

Table 8: CPOE (Computerized Physician Order Entry) Diagnostic Imaging Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.6	0.66
Task Group Satisfaction Ratings (5=very easy)	3.5	0.80

Discussion of Findings

Physician/provider participants were given two CPOE—Diagnostic Imaging tasks:

- Access Orders (a3.1)
- Record a New Radiology Order (a3.2)

Effectiveness

The success score for each of these tasks was 100%. Participants were easily able to access diagnostic imaging orders and record a new diagnostic imaging order.

Efficiency

All participants completed the tasks with either fewer steps or the same number of steps as expert users. All participants completed the tasks within the optimal time for each task, as suggested by expert timings.

Satisfaction

Participants had an average satisfaction rating of 3.4 out of 5 points on a Likert scale. Most participants were familiar with these tasks and found them straightforward and easy to complete.

Major Findings

- Participants were easily able to access diagnostic imaging orders and record a new diagnostic imaging order. These tasks were easy to complete as the pick lists for this task were clearly defined.

Areas for Improvement

- No additional areas for improvement related to effectiveness and efficiency were identified.

Criteria 170.315(a)(4) Drug-Drug, Drug-Allergy Interactions Checks

Data Analysis and Reporting

Table 9: Drug-Drug, Drug-Allergy Interaction Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Perform a Drug Interaction Check	10	1.0	0.00	87.9	5.73	1.06	1.04	0.00	0.00
Process a Drug-Drug, Drug-Allergy Interaction Alert	10	1.0	0.00	87.3	4.47	1.06	1.04	0.00	0.00
Adjust Severity Level of Interventions - Limited Permissions	10	1.0	0.00	11.9	1.57	1.4	1.19	0.00	0.00

Table 10: Drug-Drug, Drug-Allergy Interaction Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.5	0.67
Task Group Satisfaction Ratings (5=very easy)	3.5	0.92

Discussion of Findings

Physician/provider participants were given three drug-drug, drug-allergy interactions check tasks:

- Perform a Drug Interaction Check (a4.1)
- Process a Drug-Drug, Drug-Allergy Interaction Alert (a4.2)
- Adjust Severity Level of Interventions - Limited Permissions (a4.3)

Effectiveness

All participants were able to successfully perform and process a drug interaction check, yielding a task success score for each of these tasks at 100%.

Efficiency

Three participants exceeded the target time for completing the task for adjusting the severity level of an intervention. On average, the number of steps for the adjusting severity levels task was exceeded, due to some participants being unfamiliar with the task.

Satisfaction

Participants had an average satisfaction rating of 3.8 out of 5 points on a Likert scale. Most participants stated that although they were unfamiliar with the tasks, they were still easy to complete.

Major Findings

- Providers were able to identify the highest priority drug interaction in the first and second tasks with no difficulty.
- Providers were not familiar with the configuration of drug interactions, as that task is typically a function of their system administration.

Areas for Improvement

- The low familiarity rating for the configuration of severity levels task seems to indicate that more training on this feature for clinical staff would increase their awareness of the available functionality and improve its adoption.

Criteria 170.315(a)(5) Demographics

Data Analysis and Reporting

Table 11: Demographics Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access and Record Demographics	10	1.00	0.00	73.7	5.04	1	1.05	0.00	0.00
Change Demographics	10	1.00	0.00	34.8	2.82	1.06	1.08	0.00	0.00

Table 12: Demographics Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.6	1.11
Task Group Satisfaction Ratings (5=very easy)	3.8	0.872

Discussion of Findings

Nurse participants were given two demographics tasks:

- Access and Record Demographics (a5.1)
- Change Demographics (a5.2)

Effectiveness

The success score for the Access and Record Demographics task was 100%. On the Change Demographics task, the success score was also 100%. All participants were ultimately able to review the patient's demographics and complete the tasks.

Efficiency

Three participants exceeded the target time for the tasks, due to unfamiliarity. Seven out of ten participants indicated that front desk personnel at their practice, rather than nurses, typically perform demographic tasks or that they were not familiar with the demographic tasks.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale.

Major Findings

- Front desk personnel, rather than nursing staff, typically perform demographic data entry tasks.

Areas for Improvement

No additional areas for improvement related to effectiveness and efficiency were identified.

Criteria 170.315(a)(7) Medication List

Data Analysis and Reporting

Table 15: Medication List Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access Active Medications List	10	1.00	0.00	19.4	2.24	1	1.07	0.00	0.00
Access Full Medications List	10	1.00	0.00	23.4	1.95	1	1.06	0.00	0.00
Change an Existing Medication	10	0.98	0.11	25.7	1.34	1.1	1.02	0.00	0.00

Table 16: Medication List Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	4	0.89
Task Group Satisfaction Ratings (5=very easy)	3.8	0.60

Discussion of Findings

Physician/provider participants were given three medication list tasks:

- Access Active Medications List (a7.1)
- Access Full Medications List (a7.2)
- Change an Existing Medication (a7.3)

Effectiveness

The success scores for accessing the active medications list and full medications list tasks were 100%. Participants were easily able to access the medication list. The task to change an existing medication had also a success score of 100%.

Efficiency

All participants completed the tasks with the same number of steps as expert users. All participants completed the medication list access tasks within the optimal time for each task, as suggested by expert timings. Many participants struggled to change an existing medication due to a scrolling issue.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale. Most participants were familiar with these tasks and found them easy to complete.

Major Findings

- The toolbar for editing existing medications in the medication list scrolls, so participants had trouble finding it.

Areas for Improvement

No significant areas of improvement were identified in working with patient problems.

Criteria 170.315(a)(8) Medication Allergy List

Data Analysis and Reporting

Table 17: Medication Allergy List Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access Active Medication Allergies	10	1.00	0.00	13.3	1.9	1	1.10	0.00	0.00
Change an Existing Medication Allergy	10	1.00	0.00	24.5	2.24	1.05	1.22	0.00	0.00
Record a New Medication Allergy	10	1.00	0.00	20.5	2.20	1.03	1.13	0.00	0.00
Access Full Medication Allergy List	10	1.00	0.00	20.1	1.86	1	1.11	0.00	0.00

Table 18: Medication Allergy List Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	4.1	0.83
Task Group Satisfaction Ratings (5=very easy)	4	0.77

Discussion of Findings

Participants were given four medication allergy list tasks:

- Access Active Medication Allergies (a8.1)
- Change an Existing Medication Allergy (a8.2)
- Record a New Medication Allergy (a8.3)
- Access Full Medication Allergy List (a8.4)

Effectiveness

The success score for the access active medication allergy list, access full medication allergy list, and record a new medication allergy tasks was 100%. Participants were easily able to access, record, and change the medication allergies as needed.

Efficiency

Most participants exceeded the optimal number of steps for the medication allergy tasks, but all participants completed the tasks within the optimal time for each task, as suggested by expert timings.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale. Most participants were familiar with these tasks and found the workflows easy to complete.

Major Findings

- Some participants indicated that they liked that the reactions are separated into adverse reactions and allergic reactions, making the reactions easier to find.

Areas for Improvement

No significant areas of improvement were identified in working with Medication Allergies.

Criteria 170.315(a)(9) Clinical Decision Support

Data Analysis and Reporting

Table 19: Clinical Decision Support Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access and Enable CDS Interventions	10	1.00	0.00	2.02	4.20	1.05	1.06	0.00	0.00
Process and Locate Reference Information for a CDS Intervention	10	1.00	0.00	36	1.7	1.15	1.05	0.00	0.00
Check for Clinical Alerts Generated by Reconciled Medications	10	1.00	0.00	18.9	2.02	1.13	1.11	0.00	0.00

Table 20: Clinical Decision Support Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.9	0.83
Task Group Satisfaction Ratings (5=very easy)	3.6	1.02

Discussion of Findings

Physician/provider/Nurse participants were given three clinical decision support tasks:

1. Access and Enable CDS Interventions (a9.1)
2. Process and Locate Reference Information for a CDS Intervention (a9.2 & a9.3)
3. Check for Clinical Alerts Generated by Reconciled Medications (a9.4)

Effectiveness

The success score for the Access and Enable CDS Interventions task was 100%, indicating that providers could complete this task easily. Nurses successfully completed the Check for Clinical Alerts Generated by Reconciled Medications task with a success score of 100%.

Efficiency

Of the ten participants, all completed the task with the same number of steps as the experts.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale.

Major Findings

- Most participants were familiar with checking the patient's clinical alerts.
- Not many participants were aware that they had access to Medline through the Clinical Alert reference, even though it is free and easily available to use for clinical staff.

Areas for Improvement

- Providers seemed to be familiar with the patient education feature.

Criteria 170.315(a)(14) Implantable Device List

Data Analysis and Reporting

Table 21: Implantable Device List Task Results

Task Scores	N	Task Success		Task Time (sec)		Path Deviation		Errors	
Task	#	Mean	(SD)	Mean	(SD)	Deviations (Observed / Optimal)	(SD)	Mean	(SD)
Access Implantable Device List	10	1.00	0.00	10.6	1.56	1.06	1.06	0.00	0.00
Change an Existing Implantable Device	10	1.00	0.00	13.8	1.77	1.05	1.15	0.00	0.00
Record a New Implantable Device	10	1.00	0.00	44	2.79	1.02	1.1	0.00	0.00

Table 22: Implantable Device List Task Scenario

Task Scenario Ratings	Mean	(SD)
Task Group Familiarity Ratings (5=very familiar)	3.2	0.74
Task Group Satisfaction Ratings (5=very easy)	3.6	0.66

Discussion of Findings

Nurse participants were given three implantable device list tasks:

1. Access Implantable Device List (a14.1)
2. Change an Existing Implantable Device (a14.2)
3. Record a New Implantable Device (a14.3)

Effectiveness

The success score for each of these tasks was 100%. Participants were easily able to access, change, and record implantable devices

Efficiency

Although the implantable device feature was a relatively new feature, all participants were able to complete the tasks within the optimal time for each task, as suggested by expert timings.

Satisfaction

Participants had an average satisfaction rating of 4.0 out of 5 points on a Likert scale. Although unfamiliar with these relatively new tasks, most participants found them easy to complete.

Major Findings

- When entering a body site for the implanted device, many participants searched for 'knee', a term that returned too many results. A more direct search of 'left knee' returned better results.

Areas for Improvement

No significant areas of improvement were identified in working with Implantable Device List.

Overall Results

In addition to the specific findings and areas for improvement in specific features, several overall areas for improvement recurred throughout this usability study.

Low familiarity ratings with certain functionality, along with participants' lack of awareness of the existence of some functionality, may indicate a need for training and documentation that is accessible within common workflows and provided in formats that are easily consumable by busy clinical professionals.

Participants repeatedly stated that their systems were different from the test system due to customization based on user preferences. Many participants stated this customization capability as a very strong feature of the system.

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 70.13. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

Through the user-centered design and usability testing processes, opportunities to refine and enhance the user experience were identified. Some of these enhancements have been prioritized for release in upcoming release cycles. Still others will be revisited in more depth in future studies.

Appendices

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

Appendix A Participant demographics

Appendix B Recording Consent

Appendix C Sample Orientation

Appendix D Protocol Tasks

Appendix E System Usability Scale Questionnaire

The test administrator asked the questions at the beginning of the session and the data logger recorded the responses

Appendix A – Participant Demographics

Below is a summary of participant demographics for this study

PARTICIPANT GENDER

	n (N=20)	%
Male	9	45%
Female	11	55%
Other	0	0

PARTICIPANT AGE

	n (N=20)	%
40-49	8	40%
50-59	10	50%
60-69	2	10%

PARTICIPANT EDUCATION

	n (N=20)	%
No high school degree	0	
High school graduate, diploma or equivalent	0	
Trade/technical/vocational training	0	
Some college credit, no degree	0	
Associate degree	0	
Bachelor's degree	4	20%
Master's degree	4	20%
Doctorate degree (e.g., MD, DNP, DMD, PhD)	12	60%

PARTICIPANT ROLES

	n (N=20)	%
Physician	12	60%
Nurse Practitioner	8	40%

Appendix C – Volunteer, Non-Disclosure, and Video Consent Form

I voluntarily agree to participate in an evaluation being conducted by Vision Infonet Inc. This evaluation is designed to provide feedback regarding a MDCare EMR/PMS.

During the evaluation, I understand that I may learn information that is confidential to User- View or their client. I agree to treat all confidential information received during this evaluation in accordance with this non-disclosure agreement. Accordingly, I will not disclose confidential information to any third parties.
I authorize Vision Infonet Inc and their client to keep, preserve, use in any manner and dispose of the findings from this evaluation, including my feedback and opinions expressed. Vision Infonet Inc will not associate my name or company name with the results of this evaluation.

I give my permission for Vision Infonet Inc and their client to make video and audio records of me during this evaluation. I understand that these recordings can be used only for evaluation purposes and can be used for no other purpose without my knowledge and consent.

I understand that my participation is completely voluntary and that I may leave at any time.

Name Signature Date

Appendix C - Sample Orientation
Moderator Guides

Clinical Moderator Guide

MODERATOR GUIDE Summative

Participant: _____ #: _____
Location: _____ Date: _____
Specialty: _____ Time: _____

INTRODUCTION All User Groups

Hello. My name is and this is . Thank you again for coming to evaluate this application today. We will be here with you throughout the session today. Our understanding is that you can stay for 45 mins, until .

The first/next thing I would like to do is to show you this consent form to participate. <<moderator provides consent and P signs>>

So, from this point on, we will be recording the session.

Remember we are not here to test you. We are testing the application. We are trying to learn what is efficient /inefficient and what is easy / hard to do with the application.

Throughout the session I will ask you to try very specific activities. Some activities might seem simple to you. Other activities might seem difficult. And there will be some activities that you will not able to complete. I am telling you this because I want you to remember that we are not testing you. We are testing the application.

The way the session will work is; I will describe a clinical scenario. Once we both agree you understand what I am asking you to do, you will start the activity. I am not going to interact or talk to you while you are completing the activity. I do want you to talk aloud about what you are doing. You will say things like I am clicking <say the place you clicked>. Both and I will be taking notes about what you are doing.

Because I am not going to be talking with you while you do the activities, I want you to make it clear to me when you are done with an activity by saying "Done." There are a number of reasons you might be done.

1. Done because you completed the activity, you know you have completed the activity. And you are done.

2. Done because you have tried, you know you have not completed the activity, but you are not going to try anything else.
3. Done because you feel like if you asked a question you could finish the activity.
4. We have a few questions:
5. What is your job title and location?
6. Please give me a short description about what you do.
7. How long have you been in your current position?
8. How many years have you used MDCare EMR/PMS?
9. Did you have a chance to go through the materials Vision Infonet Inc sent over for training?

Before I give you control, I am going to show you a cheat sheet we have for you.
Do you have any questions before we begin?

Instructions

What you will be looking at today is MDCare EMR/PMS populated with a mock patient's information. I will be asking you to perform some workflows that a <role> might perform with MDCare EMR/PMS. Please keep in mind that the data may not be clinically accurate, and we understand that it may not be applicable to your specialty.

I will ask you to start when I say "BEGIN NOW", and please tell me when you think you've completed the workflow by saying "DONE".

Appendix D – Protocol Tasks

Physician / Provider Task 1

§170.315(a)(1) Computerized provider order entry - medications

(i) Enable a user to **record, change, and access** medication orders

Medications Order:

Access orders to place a medication order

Record: Ceftriaxone 100 MG/ML Injectable Solution, dose 1, once a day, Days of supply 6, dispense 6

Access medication orders to change an order

Change the existing medication: dose 2, twice a day, days of supply 3, dispense 3

§170.315(a)(2) Computerized provider order entry – lab orders

(i) Enable a user to **record, change, and access** lab orders

Lab order:

Access orders to place a lab order

Record: Urinanalysis macro (dipstick) panel

Access lab orders to change an order

Change: Lipid Panel

§170.315(a)(3) Computerized provider order entry – Diagnostic Imaging

(i) Enable a user to **record, change, and access** diagnostic imaging

Diagnostic Imaging Order:

Access orders to place a diagnostic imaging order

Record: Chest X-ray

Access diagnostic imaging orders to change an order

Change: Digital X-Ray Chest, 2 views

§170.315(a)(4) Drug-Drug, Drug-Allergy Interaction Checks

(i) **Interventions**. Before a medication order is completed and acted upon during computerized provider order entry (CPOE), interventions must automatically indicate to a user drug-drug and drug-allergy contraindications based on a patient's medication list and medication allergy list.

(ii) **Adjustments**.

a. Enable the severity level of interventions provided for drug-drug interaction checks to be adjusted.

b. Limit the ability to adjust severity levels in at least one of these two ways:

i. To a specific set of identified users.

ii. As a system, administrative function.

Perform a Drug Interaction Check:

1. Access Drug Interactions Check in Settings → Miscellaneous → Add Severity Level
2. Check whether all Severity levels were marked in "Severity Level" → High, Medium, & Low
3. Access orders to place a medication allergy order
4. **Record**: Ibuprofen 100 MG Oral Tablet, DOS, Severity level
5. **Record**: Aspirin 325 MG Oral Tablet, dose 1, once a day, Days of supply 6, dispenses 6.
6. If the Aspirin has any interaction with the existing drug, it shows a list of "Drug-Drug Interactions" by clicking "Show All Interactions"
7. Check the severity level, Green – Low, Yellow – Medium, Red – High
8. If you want to prescribe the medication to patient, mention the reason at the bottom of the page in "Override Reason" → Click Override.

§170.315(a)(5) Demographics

Enable a user to record, change, and access patient demographic data

(i) Access and Record Demographics
(ii) Change Demographics

Demographics Order:
Access Demographics
Record: Sex, Sexual Orientation, Gender Identity, Race at least two, Ethnicity at least two, preferred language
Change:

1. Change Unknown to Female under Sex
2. Change Straight or Heterosexual to Bisexual under Sexual Orientation
3. Change "Female to Male" to "Male to Female" under Gender Identity
4. Change Samoan and Native Hawaiian to other pacific islander under Race
5. Change Not Hispanic or Latino to South American Indian under Ethnicity
6. Change Spanish to German under Preferred Language

170.315(a)(7) Medication List

Enable a user to record, change, and access a patient's active medication list as well as medication history

Medications Order:
Access orders to place a medication order
Access active medications list → Click on Active Medication List tab → Click "Active" and review the active medications list
Record: Ceftriaxone 100 MG/ML Injectable Solution, dose 1, once a day, Days of supply 6, dispense 6
Access medication orders to change an order
Change the existing medication: dose 2, twice a day, days of supply 3, dispense 3

§170.315(a)(9) Clinical Decision Support

Enable a user to use Clinical Decision Support to improve performance on high-priority health conditions:

(i) Access and Enable CDS Interventions
(ii) Process a CDS Intervention
(iii) Locate Reference Information for a CDS Intervention

Document Problems and order medications

Step: 1

1. Open the patient chart note
2. Click on "Allergies" tab and add "Warfarin 1 MG"
3. Click save and sign
4. Click on "Medication" tab
5. Add "Carbinoxamine Maleate 0.8 MG/ML Oral Syrup" NDC-64376061216
6. Click "Save and sign"
7. In Medications tab, you will see medication and Drug-drug interactions and Drug-Allergies interactions notification
8. Select Drug-drug interactions and Drug-Allergies interactions check box, you will see the details of interactions
9. We see that the clinical rule is triggered and is turned in Yellow color with blinking.
10. Click on the clinical rule notification icon
11. In Clinical Rule Notification Window, we see that details of ("Use of High-Risk Medications in the Elderly") clinical rule are displayed.
12. Select "Final Diagnosis" tab
13. Add Diabetes Mellitus type 2 code
14. Click "Save and Sign"
15. Now we can see the Clinical Rule is triggered at the top of the application and it is turned in Yellow color with blinking.
16. Click on the Clinical Rule Notification icon
17. In Clinical Rule Notification Window, we see that details of ("Diabetes: Foot Exam") clinical rule are displayed.

Step: 2

1. In the External Clinical rule window, added Medications, Allergies, & Problems will display
2. Select the Medications, Allergies, & Problems check boxes (as suggested by proctor)
3. Click "Query" button, then it will display the "Info Button"
4. Click on the info button will navigate to the URL site
5. It will display the Developer, and Bibliographic citation (clinical research/guideline), at the bottom
6. Close the window
7. Close the chart notes

§170.315(a)(14) Implantable Device List

Enable a user to electronically access, change, record a patient's Implantable Device List:

(i) Access Implantable Device List
(ii) Record a New Implantable Device

Access Implantable Device List

1. Access the patient's implantable device list
2. Click on View to review the device list
3. Change an existing implantable device → target site, implanted date, & status → active to inactive
4. Record new implant
5. Parse and obtain information regarding implant
6. Record Target Site and Implanted Date

§170.315(a)(8) Medication Allergy List

Enable a user to record, change, and access a patient's active medication allergy list as well as medication allergy history

Medication Allergy Order:
Access active medication allergy
Click on Previous Drug Allergies and Select Status → Active and review the list of Active Medication Allergy list
Record: ibuprofen 200 MG Oral Capsule, Start Date, Severity, Status
Access medication orders to change an order
Change the existing medication allergy list: Start Date, Severity, and Status

Appendix E – System Usability Questionnaire

SUS

Based on your overall experience with all the tasks, please answer the following questions.

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

   Strongly Disagree 1 2 3 4 5 Strongly Agree

2. **I found the system unnecessarily complex**

   Strongly Disagree 1 2 3 4 5 Strongly Agree

3. **I thought that the system was easy to use**

Strongly Disagree 1 2 3 4 5 Strongly Agree

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

   Strongly Disagree 1 2 3 4 5 Strongly Agree

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

   Strongly Disagree 1 2 3 4 5 Strongly Agree

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

   Strongly Disagree 1 2 3 4 5 Strongly Agree

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

   Strongly Disagree 1 2 3 4 5 Strongly Agree

8. **I found the system very cumbersome to use**

   Strongly Disagree 1 2 3 4 5 Strongly Agree

9. **I felt very confident using the system**

   Strongly Disagree 1 2 3 4 5 Strongly Agree

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

    Strongly Disagree 1 2 3 4 5 Strongly Agree