

EHR
Usability
Test
Report of
ERMA
6.85.1

July 6

2020

The purpose of this document is to report the results of the usability testing of the Electronic Record Management Application (ERMA) for the following modules identified in the Safety Enhanced Design criterion for which ONC Certification is sought: Drug-Drug and Drug-Allergy Interaction Checks, Medication Allergy List and Medication List.

Usability
Testing
Report

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EHR Usability Test Report of ERMA 6.85.1

Report based on ISO/IEC 25062:2006 Common Industry Format for Usability Test Reports

Electronic Records Management Application (ERMA)

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Report Prepared By: Ellen Wiesner

Contact Person: Mike Gager, Vice President of Clinical Technology, Wellpath, Inc.

Phone: 615-466-3612

Email: mgager@wellpath.us

Mailing Address: 1283 Murfreesboro Road, Ste. 500, Nashville, TN 37217

EXECUTIVE SUMMARY

A usability test of the Electronic Record Management Application (EMRA), Version 6.85.1, electronic medical record system was conducted between June 22, 2020 and July 2, 2020 utilizing a remote testing session via Microsoft Teams. The purpose of this test was to test and validate the usability of the current user interface, and provide evidence of usability in the EHR Under Test (EHRUT). During the usability test, five healthcare professionals matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

This study collected performance data on 14 tasks typically conducted on an electronic health record. A user path for each task was identified and prioritized in accordance with identifying the risk associated with possible user errors. The following tasks were tested during the usability testing.

- **CPOE Medication List**
 - Record CPOE Medication Order
 - Change CPOE Medication Order
 - Access CPOE Medication Order
- **Drug-drug interaction and drug-allergy interaction checks**
 - Locate drug-allergy interaction checks when entering a medication order.
 - Locate drug-drug interaction checks when entering a medication order.
 - Adjust the severity level of a displayed drug-drug interaction
- **Medication List**
 - Access the patient's inactive medication orders.
 - Access the patient's current medication list.
 - Enter (record) a medication order.
 - Discontinue (change) a medication order.
- **Medication Allergy List**
 - Access the inactive medication allergy list.
 - Access the active medication allergy list.
 - Enter (record) a medication allergy.
 - Discontinue (change) a medication allergy.

During the usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All ten participants had prior experience with the EHR. The administrator introduced the test, and instructed participants to complete a series of tasks (given one at a time) using the EHRUT. During the testing, the administrator timed the test and recorded user performance data on paper and electronically. The administrator did not give the participants assistance on how to complete the task.

The following types of data were collected for each participant:

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

All participant data was de-identified. No correspondence could be made from the identity of the participant to the data collected. Following the conclusion of the testing, participants were asked to complete a post-test questionnaire. Various recommended metrics, in accordance with the examples set forth in the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records*, were used to evaluate the usability of the EHRUT. Following is a summary of the performance and rating data collected on the EHRUT.

Task	N	Task Success	Path Deviation	Task Time		Errors	Task Ratings
	#	Mean (SD)	Deviations (Observed/Optimal)	Mean (SD)	Deviations (Obs/Opt)	Mean (SD)	Mean (SD)
a.8-1: Enter a medication allergy and reaction.	1	90%	0.5	30.7 sec 3.6 SD	.71 sec	0.2 0.4 SD	4.8 0.4 SD
a.8-2: Discontinue a medication allergy.	1	90%	0.1	16.2 sec 2.18 SD	.78 sec	0	5.0 0 SD
a.8-3: Access inactive medication allergy list.	1	80%	0.1	4.0 sec 1.4 SD	.86 sec	0	4.8 0.4 SD
a.8-4: Access active medication allergy list.	1	100%	0.0	5.0 sec 6.7 SD	1.0 sec	0.4 .48 SD	4.4 .48 SD
a.7-1: Enter a medication order.	1	100%	1.0	65.4 sec 3.1 SD	.79 sec	0.2 0.4	5.0 0 SD

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a.7-2: Discontinue a medication order.	1	100%	0.0	11.5 sec 1.24 SD	.74 sec	0	5.0 0 SD
a.7-3: Access the active medication orders list.	1	100%	0.0	5.0 sec .49 SD	1.7 sec	0	4.8 0.4 SD
a.7-4: Access the inactive medication orders list.	1	90%	0.5	9.5 sec 4.5 SD	.78 sec	0.2 0.4 SD	5.0 0 SD
a.4-1: Locate drug-drug interaction warning.	1	100%	0.0	5.0 sec 3.6 SD	.66 sec	0	4.8 0.4 SD
a.4-2: Locate the drug-allergy interaction warning.	1	100%	0.0	5.0 sec .31 SD	1.05 sec	0	5.0 0 SD
a.4-3: Adjust the severity level of a displayed drug-drug interaction	1	100%	0.0	5.0 sec 0	0	0	4.8 .4SD
a.1-1: Record CPOE Medication Order	1	100%	1.0	65.4 sec 3.1 SD	.79 sec	0.2 0.4	5.0 0 SD
a.1-2: Change CPOE Medication Order	1	100%	0.0	11.5 sec 1.24 SD	.74 sec	0	5.0 0 SD
a.1-3: Access CPOE Medication Order	1	100%	0.0	5.0 sec 3.6 SD	.66 sec	0	4.8 0.4 SD

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be: 77.

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

- Major findings:
 - Overall, like previous tests, test participants verbalized the allergy and medication order entry tasks were easy to complete within the system.
 - Users found having allergies displayed in patient profile in red helpful
 - Users verbalized the drug-drug interaction and drug allergy checks were easily identified prior to medication order entry submission.

- Medication order entry screen is “simple and straight forward” and useful for entering and modifying medication orders.
- Patient Profile section gives the user a quick and efficient way of obtaining and documenting patient information related to medication allergies and medication orders.
- Areas for improvement:
 - Inability to access the inactive medication allergies from the home screen (patient profile) of the patient chart.
 - Inability to access the inactive medication orders from the home screen (patient profile) of the patient chart.
 - Participants verbalized the need to modify the medication order instructions after the medication order has been submitted.

1. INTRODUCTION

The EHRUT(s) tested for this study was ERMA, Version 6.85.1. Designed to present medical information to healthcare professionals in a Correctional setting, the EHRUT consists of an Electronic Health Record system used by healthcare staff within Correctional Facilities. The usability testing attempted to represent realistic exercises and conditions.

The purpose of this study was to test and validate the usability of the current user interface and provide evidence of usability in the EHRUT. To this end, measures of effectiveness, efficiency and user satisfaction, such as time on task, optimal path for task completion, task path deviations and user errors during task completion were captured during the usability testing.

2. METHOD

PARTICIPANTS

A total of 10 participants were tested on the EHRUT. Participants in the test were healthcare or healthcare operations professionals. Participants were recruited by Bonnie Bernard, Wellpath Director of Clinical IT Implementation and Support. In addition, participants had no direct connection to the development of or organization producing the EHRUT. Participants were not from the testing or supplier organization.

For the test purposes, end-user characteristics were identified and translated into a recruitment screener used to solicit potential participants. Recruited participants had a mix of backgrounds and demographic characteristics conforming to the recruitment screener. The following is a table of participants by characteristics, including demographics, professional experience, computing experience and user needs for assistive technology. Participant names

were replaced with Participant IDs so that an individual’s data cannot be tied back to individual identities.

Participants

Part ID	Gender	Age	Education	Occupation/ Role	Prof Exper.	Comp Exper.	Prod Exper.	Asst. Tech Needs
001	Female	30-39	Bachelor's Degree	RN Administraton	120	120	24	No
002	Male	30-39	Some college credit, no degree	Support	144	120	120	No
003	Female	30-39	Some college credit, no degree	Support	36	120	36	No
004	Female	40-49	Master's Degree	Support	72	120	36	No
005	Male	40-49	Associate degree	Implementation Specialist	288	120	72	No
006	Male	50-59	Bachelor's Degree	Implementation Manager	180	120	120	No
007	Male	30-39	Associate degree	Implementation Specialist	144	120	60	No
008	Male	50-59	Some college credit, no degree	Support	372	120	36	No
009	Female	40-49	Associate degree	Support	36	120	18	No
010	Male	50-59	Bachelor's Degree	Support	408	120	36	No

Ten participants (matching the demographics in the section on Participants) were recruited and ten participated in the usability test. No participants failed to show for the study.

Participants were scheduled for 30 minute. A table was used to keep track of the participant schedule, and included each participant’s demographic characteristics.

3. STUDY DESIGN

Overall, the objective of this test was to uncover areas where the application performed well – that is, effectively, efficiently, and with satisfaction – and areas where the application failed to meet the needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same EHR and/or comparison with other EHRs provided

the same tasks are used. In short, this testing serves as both a means to record or benchmark current usability, but also to identify areas where improvements must be made.

During the usability test, participants interacted with one EHR. Each participant used the system in a remote location and was provided with the same instructions. The system was evaluated for effectiveness, efficiency and satisfaction as defined by measures collected and analyzed for each participant:

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

4. TASKS

Several tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this electronic health record, including:

1. a.8-1: Add a medication allergy and the allergy reaction.
2. a.8-2: Discontinue a medication allergy.
3. a.8-3: Locate/access the patient's active medication allergy list.
4. a.8-4: Locate/access the patient's inactive medication allergy list.
5. a.7-1: Add a medication order.
6. a.7-2: Discontinue a medication order.
7. a.7-3: Locate/access the patient's active medication list.
8. a.7-4: Locate/access the patient's inactive medication list.
9. a.4-1: Enter a medication order and locate the drug-drug interaction notification.
10. a.4-2: Enter a medication order and locate the drug-allergy interaction notification.
11. a.4-3: Adjust the severity level of a displayed drug-drug interaction
12. a.1-1: Record CPOE Medication Order
13. a.1-2: Change CPOE Medication Order
14. a.1-3: Access CPOE Medication Order

These tasks were prioritized in accordance with user error risk.

5. PROCEDURES

The participants accessed the remote testing session via Microsoft Teams, participants were greeted; their identity was verified and matched with a name on the participant schedule. Participants were then assigned a participant ID.

The usability testing staff conducting the test was the Director of Clinical IT Implementations and Support. The administrator moderated the session including administering instructions and tasks. The administrator also monitored task times, obtained post-task rating data, and

took notes on participant comments and took notes on task success, path deviations, number and type of errors, and comments.

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

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

For each task, the participants were given a written copy of the task. Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated they had successfully completed the task.

Following the session, the administrator gave the participant the post-test questionnaire 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.

6. TEST LOCATION

The usability test was conducted remotely. The testing participants accessed and utilized a remote sharing session via Microsoft Teams to complete the usability testing. The participants utilized a facility computer for the testing session and the administrator utilized the recording computer for the testing session. Only the participant and administrator were on the remote testing session during the usability test. The administrator and the data logger worked in a conference room where they could see the participant's screen and listen to the audio of the session. To ensure that the environment was comfortable for users, noise levels were kept to a minimum.

7. TEST ENVIRONMENT

The EHRUT would be typically used in a healthcare office or facility. In this instance, the testing was conducted in a correctional healthcare facility. For testing, the computer used was a desktop PC running Windows 10. The participants used a mouse and keyboard when interacting with the EHRUT. The EHRUT used a 17" monitor with a 1280 x 1024 screen resolution. The application was set up by the vendor according to the vendor's documentation describing the system set-up and preparation. The application itself was running on a Windows platform using a QA test database on a LAN connection. Technically, the system performance was representative to what actual users would experience in a field implementation. Additionally, participants were instructed not to change any of the default system settings.

8. TEST FORMS AND TOOLS

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

1. Administrators Guide
2. Usability Test Results Capture Sheet
3. Post-test Questionnaire

The participant's interaction with the EHRUT was captured and recorded with screen sharing software running on the test machine. A Microsoft Teams sharing session with the participant recorded both audio and video for each participant's testing session.

9. PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our session today will last about 30 minutes. During that time you will use ERMA. I will ask you to complete a few tasks using this system and answer some questions. You should complete the tasks as quickly as possible making as few errors as possible. Please try to complete the tasks on your own following the instructions very closely. Please note that we are not testing you we are testing the system, therefore if you have difficulty all this means is that something needs to be improved in the system. I will be here in case you need specific help, but I am not able to instruct you or provide help in how to use the application.

Overall, we are interested in how easy (or how difficult) this system is to use, what in it would be useful to you, and how we could improve it. Please be honest with your opinions. All of the information that you provide will be kept confidential and your name will not be associated with your comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

For each task, I will read the description to you and say "Begin." At that point, please perform the task and say "Done" once you believe you have successfully completed the task. I would like to request that you not talk aloud or verbalize while you are doing the tasks. I will ask you your impressions about the task once you are done.

Participants were then given 14 tasks to complete.

10. USABILITY METRICS

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

1. Effectiveness of ERMA by measuring participant success rates and errors.

2. Efficiency of ERMA by measuring the average task time and path deviations.
3. Satisfaction with ERMA by measuring ease of use ratings.

11. DATA SCORING

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

Table [1]

Measures	Rationale and Scoring
Effectiveness: Task Success	<p>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.</p> <p>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.</p> <p>Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency.</p> <p>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.</p>
Effectiveness: Task Failures	<p>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.</p> <p>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.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected. This should also be expressed as the mean number of failed tasks per participant.</p>
Efficiency: Task Deviations	<p>The participant’s path (i.e., steps) through the application was recorded. Deviations occur if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation. It is strongly recommended that task deviations be reported. Optimal paths (i.e., procedural steps) should be recorded when constructing tasks.</p>

<p>Efficiency: Task Time</p>	<p>Each task was timed from when the administrator said “Begin” until the participant said, “Done.” If he or she failed to say “Done,” the time was stopped when the participant stopped performing the task. Only task times for tasks that were successfully completed were included in the average task time analysis. Average time per task was calculated for each task. Variance measures (standard deviation and standard error) were also calculated.</p>
<p>Satisfaction: Task Rating</p>	<p>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.</p> <p>Common convention is that average ratings for systems judged easy to use should be 3.3 or above.</p> <p>To measure participants’ confidence in and likeability of ERMA 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.”</p>

12. RESULTS

DATA ANALYSIS AND REPORTING

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

The usability testing results for the EHRUT are detailed below (see Table 2). The results should be seen considering the objectives and goals outlined in Section 3. Study Design. The data should yield actionable results that, if corrected, yield material, positive impact on user performance. The data is presented in the table below so that the tasks can be easily identified and their performance results examined and compared.

Table [2]

Task	N	Task Success	Path Deviation	Task Time		Errors	Task Ratings
	#	Mean (SD)	Deviations (Observed/Optimal)	Mean (SD)	Deviations (Obs/Opt)	Mean (SD)	Mean (SD)
a.8-1: Enter a medication allergy and reaction.	1	90%	0.5	30.7 sec 3.6 SD	.71 sec	0.2 0.4 SD	4.8 0.4 SD
a.8-2: Discontinue a medication allergy.	1	90%	0.1	16.2 sec 2.18 SD	.78 sec	0	5.0 0 SD
a.8-3: Access inactive medication allergy list.	1	80%	0.1	4.0 sec 1.4 SD	.86 sec	0	4.8 0.4 SD
a.8-4: Access active medication allergy list.	1	100%	0.0	5.0 sec 6.7 SD	1.0 sec	0.4 .48 SD	4.4 .48 SD
a.7-1: Enter a medication order.	1	100%	1.0	65.4 sec 3.1 SD	.79 sec	0.2 0.4	5.0 0 SD
a.7-2: Discontinue a medication order.	1	100%	0.0	11.5 sec 1.24 SD	.74 sec	0	5.0 0 SD
a.7-3: Access the active medication orders list.	1	100%	0.0	5.0 sec .49 SD	1.7 sec	0	4.8 0.4 SD
a.7-4: Access the inactive medication orders list.	1	90%	0.5	9.5 sec 4.5 SD	.78 sec	0.2 0.4 SD	5.0 0 SD
a.4-1: Locate drug-drug interaction warning.	1	100%	0.0	5.0 sec 3.6 SD	.66 sec	0	4.8 0.4 SD
a.4-2: Locate the drug-allergy interaction warning.	1	100%	0.0	5.0 sec .31 SD	1.05 sec	0	5.0 0 SD
a.4-3: Adjust the severity level of a displayed drug-drug interaction	1	100%	0.0	5.0 sec 0	0	0	4.8 .4SD

a.1-1: Record CPOE Medication Order	1	100%	1.0	65.4 sec 3.1 SD	.79 sec	0.2 0.4	5.0 0 SD
a.1-2: Change CPOE Medication Order	1	100%	0.0	11.5 sec 1.24 SD	.74 sec	0	5.0 0 SD
a.1-3: Access CPOE Medication Order	1	100%	0.0	5.0 sec 3.6 SD	.66 sec	0	4.8 0.4 SD

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be: 77. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

13. DISCUSSION OF THE FINDINGS

The EHRUT provided ease of use for the areas of patient medication allergy documentation and medication order entry as verbalized by the testing participants. The testing participants stated the allergy reaction functionality was simple to use and allowed the user to select more than one allergy reaction prior to submitting the patient allergy. They found this functionality useful. The drug to drug and drug to allergy interaction checks were readily identified by the test participants prior to medication order submission which alerted the user if modifications needed to be made to the original medication order(s). The test participants stated that the patient profile feature of the system allowed the user to quickly enter both allergy information and medication orders for the patient with minimal navigation within the application. The users also stated the patient profile feature of the system also gave them instant access to current medication orders and active patient medication allergy information. Overall, the users found the system easy to use.

14. EFFECTIVENESS

The effectiveness of the EHRUT was demonstrated by the test participants when completing the tasks as evidenced by 100% task completion for seven testing tasks and 80% completion for four of the testing tasks. The task that produced path deviation and caused two testing participants to demonstrate error in completing the task was “Discontinuing a medication allergy.” The user has the option to “Inactivate” or “Remove” an allergy which caused confusion for the user attempting to “Discontinue” a medication allergy. They verbalized that the word “Discontinued” should be a selectable option for allergies. Therefore, this caused deviation from the optimal path during the completion of the task because the user performed extra navigation steps in an attempt to locate the word “Discontinue” and associate it to the allergy.

15. EFFICIENCY

The efficiency of the EHRUT was demonstrated by the test participants successfully completing the assigned tasks within the optimal identified task time for each task. The task that produced failure and multiple deviations for two test participants was the “Discontinue a medication allergy” task as referenced in the Effectiveness section above.

16. SATISFACTION

The user satisfaction of the EHRUT was measured using the System Usability Scale. After each testing session, the test participants were asked to complete the System Usability Scale. The results were compiled, and the resulting System Usability Scale rating of the system was 77. The above average rating for the System Usability Scale is 80 and a below average rating is 60. The test participants were asked to rate each task on a scale from 1 – Very Difficult, to 5 – Very Easy upon completion of the task. The test participants rated eight of the twelve testing tasks as a “5” being “Very Easy” and the remainder of the tasks demonstrating a standard deviation ranging from .2 to .4.

17. MAJOR FINDINGS

Major findings in the EHRUT are as follows:

- Overall, like previous tests, test participants verbalized the allergy and medication order entry tasks were easy to complete within the system.
- Users found having allergies displayed in patient profile in red helpful
- Users verbalized the drug-drug interaction and drug allergy checks were easily identified prior to medication order entry submission.
- Medication order entry screen is “simple and straight forward” and useful for entering and modifying medication orders.
- Patient Profile section gives the user a quick and efficient way of obtaining and documenting patient information related to medication allergies and medication orders.

18. AREAS FOR IMPROVEMENT

The areas for improvement for the EHRUT are as follows:

- Inability to access the inactive medication allergies from the home screen (patient profile) of the patient chart.
- Inability to access the inactive medication orders from the home screen (patient profile) of the patient chart.
- Participants verbalized the need to modify the medication order instructions after the medication order has been submitted.