

EHR Usability Test Report

Safety Enhanced Design 170.315(g)(3)

Computerized Provider Order Entry (CPOE)–Medications(a)1

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – CPOE: Medications 170.315(a)1

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

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EXECUTIVE SUMMARY

A usability test of CPOE-Medications in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data on three (3) tasks typically conducted on an EHR:

- **Record Medication Order via CPOE**
- **Change Medication Order via CPOE**
- **Access and record existing medication order**

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)1 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315(a)1 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|-------------------------|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Record medication order | 15 | | | | | | |
| Change medication order | 15 | | | | | | |
| Review medication order | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study was the CPOE-Medications functionality in WebHIS 2.0. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset

systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- ***Enter an order for Pantoprazole 40 mg, daily***
- ***Change the above order to Pantoprazole 40 mg, twice a day (BID)***
- ***Review the list of existing medication orders in the CPOE screen***

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.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital's simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department 'Desktop Support Division', according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Objective Test Data Forms for 170.315(a)1

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 1(a) Enter new medication order in CPOE |
| Task | Enter an order for Pantoprazole 40 mg. daily. Save the order to the order basket but do not place the order. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 1(b) Change medication order in CPOE |
| Task | Change the frequency of Pantoprazole 40 mg. daily to twice daily and then place the order. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 1(c) Review and record medication orders from CPOE screen |
| Task | Review the patient medication list in the CPOE screen and record the medications |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our CPOE medication Safety Enhanced Design test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks to complete relating to CPOE – Medications.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 172.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|------------------------|----|-----------------|--|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)1 | # | Mean (SD) | Deviations (Observed/Optimal) (SD) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter med order | 15 | 100% | 1.19 | 80.5 sec | 89.5% | 1.53 | 3.79 |
| Change med order | 15 | 100% | 1.20 | 52 sec | 86.7% | 1.40 | 3.87 |
| Review med order | 15 | 100% | 1.50 | 34.9 sec | 87.3% | 1.00 | 4.00 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - The CPOE medication ordering screen does not provide the end-user with an easy way to search by route or classification of medication – ie: large volume fluids, injectables, antibiotics, etc.
 - It was not obvious to the untrained user that existing orders could be updated, renewed and modified without placing additional orders (under the ‘active medications’ list).
 - User comments mentioned the ability to quickly add a STAT medication order.

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Add a STAT option to the main CPOE screen for rapid ordering of emergency drugs.
 - Differentiate among the various filter buttons. The ‘all orders’, ‘personal favorites’, ‘order sets’, etc. buttons are not obviously differentiated.
 - Highlight the update, renew and modify icons on the CPOE medication list to make them more immediately evident to the user.
 - Provide filters for medication types – ie: large volume fluids, injectables, antibiotics, etc.

EFFECTIVENESS

Overall it was found that the effectiveness of the CPOE – Medication system was very high, based on both participant satisfaction as well as the overall System Usability Scale score. The recommended modifications will make the system more efficient but likely not more effective.

EFFICIENCY

The efficiency of this application based on time –

Enter New Medication order – the optimal time for this task was determined to be 90 seconds. The average participant time as demonstrated during the test was 80.5 seconds.

Change Medication Order – the optimal time for this task was determined to be 60 seconds. The average participant time as demonstrated during the test was 52 seconds.

Review Medication Orders – the optimal time for this task was determined to be 40 seconds. The average participant time as demonstrated during the test was 34.9 seconds.

The efficiency of this application based on path deviations (number of clicks):

Enter New Medication order – the optimal number of clicks for this task was determined to be 8. The average number of clicks demonstrated during the test was 9.53.

Change the Medication Order – the optimal number of clicks for this task was determined to be 7. The average number of clicks demonstrated during this test was 8.40.

Review Medication Order – the optimal number of clicks for this task was determined to be 2. The average number of clicks demonstrated during this test was 3.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being ‘very easy’ to 1 being ‘very difficult’, the average user rating for each of the Medication CPOE options is as follows:

| | |
|---------------------------------------|------------|
| CPOE – enter medication order | 3.8 |
| CPOE – change medication order | 3.9 |
| CPOE - review medication order | 4.0 |

Participant comments overall reflected a very high satisfaction rate with the CPOE medication system, as noted in the following quotes collected from the follow up forms:

“Quick and easy to use; it is just like online shopping.”

“I had no issues with this test.”

“System is simple, easy.”

EHR Usability Test Report - 170.315(g)(3)-Safety Enhanced Design Computerized Order Entry-Laboratory(a)2

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EHR USABILITY TEST REPORT – CPOE: Laboratory Orders 170.315(a)2

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

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EXECUTIVE SUMMARY

A usability test of CPOE-Laboratory Orders in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data on three (3) tasks typically conducted on an EHR:

- **Enter Laboratory Test Order via CPOE**
- **Change Laboratory Test Order via CPOE**
- **Access and record existing laboratory result**

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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
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- Path deviations
- Participant's verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for **170.315(a)2** is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315(a)2 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|------------------------|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter lab order | 15 | | | | | | |
| Change lab order | 15 | | | | | | |
| Review lab results | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study were tasks associated with CPOE-Laboratory Order functionality in WebHIS 2.0. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
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| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
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| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions in the course of all the testing, with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule and included each participant’s demographic characteristics.

STUDY DESIGN

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, and a means to identify areas where improvements should be made.

During the usability test, participants interacted with one EHR. Each participant used the system in the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- **Enter an order for a routine morning CBC**
- **Change the above order to a STAT order**
- **Identify and record the patient's most recent LDL results**

Tasks were selected based on their frequency of use and criticality of function. Tasks should always be constructed in light of the study objectives.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital's simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department **Desktop Support Division** according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Objective Test Data Forms for 170.315(a)2

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 2(a) Enter new Laboratory order in CPOE |
| Task | Enter an order for Complete Blood Count (CBC) for early AM. Save the order to the order basket but do not place the order. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 2(b) Change the Laboratory order in CPOE |
| Task | Change the Complete Blood Count (CBC) order from early AM to STAT. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 2(c) Review patient's laboratory orders. |
| Task | <i>In patient's laboratory orders, identify most recent Lipid Profile and record the LDL.</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our CPOE Laboratory Orders Enhanced Design test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you have general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks to complete relating to **CPOE – Laboratory Orders**.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 172.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|------------------------|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)2 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean |
| Enter lab order | 15 | 100% | 1.29 | 50.7 sec | 84.4% | 1.73 | 4.00 |
| Change order | 15 | 100% | 1.20 | 44.5 sec | 89.0% | 0.6 | 4.13 |
| Review results | 15 | 100% | 1.10 | 36.5 sec | 81.0% | 0.40 | 4.07 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- **Major Findings –**
 - **The CPOE Laboratory order screen does not provide the end-user with an easy way to search by laboratory department – blood bank, microbiology, etc.**
 - **It was not obvious to the untrained user that an order already in the order basket could be changed as opposed to deleting the order and entering a new one with the newest criteria.**
 - **There is no STAT lab order entry or ‘quick list’ to select from.**

AREAS FOR IMPROVEMENT

- **Areas for Improvement**
 - **Add a STAT option to the main CPOE screen for rapid ordering of emergency drugs.**
 - **Differentiate among the various filter buttons. The ‘all orders’, ‘personal favorites’, ‘order sets’, etc. buttons are not obviously differentiated.**
 - **Include the ability to filter laboratory orders by individual department for easier searching.**

EFFECTIVENESS

Overall it was found that the effectiveness of the **CPOE – Laboratory Order** system was very high, based on both participant satisfaction as well as the overall System Usability Scale score. The recommended modifications will make the system more efficient but likely not more effective.

EFFICIENCY

The efficiency of this application based on time

Enter new laboratory order – the optimal time for this task was determined to be 60 seconds. The average time as demonstrated during the test was 50.7 seconds.

Modify the laboratory order – the optimal time for this task was determined to be 50 seconds. The average time as demonstrated during the test was 44.5 seconds.

Review results of specified test – the optimal time for this task was determined to be 45 seconds. The average time as demonstrated during the test was 36.5 (36.47) seconds.

Efficiency of this application based on path deviations (number of clicks):

Enter new laboratory order – the optimal number of clicks for this task was determined to be 6. The average number of clicks demonstrated during the test was 7.7.

Modify the laboratory order – the optimal number of clicks for this task was determined to be 3. The average number of clicks demonstrated during this test was 3.6

Review results of specified test – the optimal number of clicks for this task was determined to be 4. The average number of clicks demonstrated during this test was 4.4.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Laboratory test cases is as follows:

| | |
|------------------------------------|------|
| CPOE – enter laboratory order | 4.0 |
| CPOE – change laboratory order | 4.36 |
| CPOE – retrieve laboratory results | 4.13 |

Participant comments overall reflected a very high satisfaction rate with the CPOE laboratory system, as noted in the following quotes collected from the follow up forms:

“Quick and easy to use; it is just like online shopping.”

“Finding results was very easy. I even checked out the trending.”

“Overall, the system is easy, but it would be faster if we could sort out the lab departments.”

“Please add a ‘STAT’ quick list for faster entry of stat orders.”

EHR Usability Test Report –
170.315(g)(3)– Safety Enhanced Design
Computerized Provider Order Entry – Radiology Orders (a)3

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – CPOE: Radiology Orders 170.315(a)3

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

STL Contact Person, Title and Affiliation: Deborah Ross, Clinical Analyst

STL Phone Number: 201-833-7114

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EXECUTIVE SUMMARY

A usability test of CPOE-Radiology Orders in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data on three (3) tasks typically conducted on an EHR:

- Enter a Radiology Order via CPOE
- Change the Radiology Order via CPOE
- Access and review an existing Radiology result

During the twenty (20) minute summative usability test, each participant was greeted by the administrator, and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for **170.315(a)3** is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315(a)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|-------------------------------|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)3 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter Radiology order | 15 | | | | | | |
| Change Radiology order | 15 | | | | | | |
| Review Radiology Report | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study was the CPOE-Radiology Order functionality in WebHIS 2.0. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

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PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
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| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset

systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

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 the same 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:

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- 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 section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- ***Enter an order for a Left Ankle x-ray due to fracture and don't place order***
- ***Change the above order to a Right Ankle and add the reason 'dislocation'***
- ***Identify and review the patient's most recent portable chest x-ray result***

Tasks were selected based on their frequency of use and criticality of function. Tasks should always be constructed in light of the study objectives.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital's simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department 'Desktop Support Division', according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Objective Test Data Forms for 170.315(a)3

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 3(a) Enter a Radiology order in CPOE |
| Task | Enter an order for a Left Ankle x-ray due to fracture. Do not place the order. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 3(b) Modify a Radiology order in CPOE |
| Task | Change the above order to Right ankle and add the reason 'dislocation'. Place the order. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 3(c) Review and record x-ray results |
| Task | Identify your patient's most recent portable chest x-ray order and review the impression. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our CPOE Radiology Orders Enhanced Design test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks to complete relating to CPOE – Radiology Orders.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 172.315(a)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|-------------------------------|----|-----------------|--------------------------------|--------------|--------------------------------|--------------|-----------------------------|
| Task | # | Mean (SD) | Deviations Observed/Optimal | Mean (SD) | Deviations Observed/Optimal | Mean (SD) | Mean |
| Enter Radiology order | 15 | 100% | 1.16 | 53.13 sec | 75.9% | 1.4 | 4.00 |
| Change Radiology order | 15 | 100% | 1.14 | 37.7 sec | 83.7% | 0.87 | 4.07 |
| Review Radiology Report | 15 | 100% | 1.17 | 36.2 sec | 80.4% | 0.33 | 4.13 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - The CPOE Radiology ordering screen does not provide the end-user with an easy way to search by diagnostic department – CT Scans, MRI, General Diagnostics, etc.
 - It was not obvious to the untrained user that an order sitting in the order basket could be changed as opposed to deleting the order and entering a new one with the newest criteria.
 - There is no STAT radiology order entry or ‘quick list’ to select from.
 - It was not obvious at the outset that there was only a single order for each body part that involves ‘laterality’. Some users stated searching using ‘left’ in the search field rather than ankle, with no results.

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Add a STAT option to the main CPOE screen for rapid ordering of emergency tests.

- Differentiate among the various filter buttons - 'all orders', 'personal favorites', 'order sets', etc. buttons are not obviously differentiated. Will consider using color to differentiate.
- Include the ability to filter Radiology orders by individual department for easier searching – ie: CT Scan, MRI, etc.

EFFECTIVENESS

Overall it was found that the effectiveness of the CPOE – Radiology Order system was very high, based on both participant satisfaction as well as the overall System Usability Scale score. The recommended modifications will make the system more efficient but likely not more effective.

EFFICIENCY

The efficiency of this application based on time -

Enter new radiology order – the optimal time for this task was determined to be 70 seconds. The average time as demonstrated during the test was 53 seconds. The efficiency rate for time was calculated to be 88.3%.

Modify the radiology order – the optimal time for this task was determined to be 45 seconds. The average time as demonstrated during the test was 38 seconds (37.6). The efficiency rate calculated for time was 83.7%.

Review radiology report – the optimal time for this task was determined to be 45 seconds. The average time as demonstrated during the test was 36 seconds. The efficiency rate calculated for time was 80.4%.

Efficiency of this application based on path deviations (number of clicks) -

Enter new radiology order – the optimal number of clicks for this task was determined to be 9. The average number of clicks demonstrated during the test was 10.4. The efficiency demonstrated by the number of clicks for this task was calculated to be 88.3%.

Change the radiology order – the optimal number of clicks for this task was determined to be 6. The average number of clicks demonstrated during this test was 6.9. The efficiency demonstrated by the number of clicks for this task was calculated to be 89.9%.

Review radiology report – The optimal number of clicks for this task was determined to be 2. The average number of clicks demonstrated during this 2.3. The efficiency demonstrated by the number of clicks for this task was calculated to be 90%.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Radiology tasks is as follows:

| | |
|--------------------------------|------|
| CPOE – Enter Radiology order | 4.00 |
| CPOE – Change Radiology order | 4.07 |
| CPOE – Review Radiology report | 4.13 |

Participant comments overall reflected a very high satisfaction rate with the CPOE medication system, as noted in the following quotes collected from the follow up forms:

“Quick and easy to use; it is just like online shopping.”

“Finding correct reports was relatively easy. Is there a way to search by term? That would be easier.” (note – there is a way to do this)

“Overall, the system is easy, but it would be faster if we could sort out the Radiology departments when placing orders.”

EHR Usability Test Report
170.315(g)(3) Safety Enhanced Design
CPOE Drug/Drug & Drug/Allergy Interaction Checking (a)4

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Drug/Drug & Drug/Allergy Interaction Checking

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

STL Contact Person, Title and Affiliation: Deborah Ross, Clinical Analyst

STL Phone Number: 201-833-7114

STL Email Address: debross@mail.holyname.org

STL Mailing Address: 718 Teaneck Road, Teaneck, New Jersey 07666

EXECUTIVE SUMMARY

A usability test of CPOE-Drug/Drug and Drug/Allergy Interaction Checking in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data on two (2) tasks typically conducted on an EHR:

- Enter an order for Penicillin 500 mg p.o. and verify that an allergy alert launches
- Enter an order for Ondansetron 2 mg. IV and for Amiodarone 200 mg p.o. and note the interaction alert

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)4 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315g(3) | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|--------------------------|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)4 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Drug/Drug Interaction | 15 | | | | | | |
| Drug/Allergy Alert | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study utilized the CPOE-Medication ordering functionality in WebHIS 2.0, but included the added features of **Medication Allergy Alert**, based on the patient’s documented allergies, as well as **Drug/Drug interactions** based on evidence-based databases utilized by the EHRUT. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- ***For your patient with a documented penicillin allergy, enter a CPOE order for Penicillin 500 mg p.o. four (4) times a day. Note whether or not an allergy alert appears at the time of ordering.***
- ***Enter a CPOE order for Amiodarone 200 mg. p.o. daily into the basket. Then enter an order for Ondansetron 2mg every six (6) hours. Note whether or not an interaction notification appears and note whether or not you are able to modify this alert.***

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.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital’s simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data,

and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department **Desktop Support Division** according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 4(a) Drug/Allergy Interactions |
| Task | <i>For your patient with a documented Penicillin allergy, enter an order for Penicillin 500 mg. p.o. four times a day. Note the allergy alert that pops up.</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|--|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 4(a) Drug/drug interaction |
| Task | Enter the following medication orders for your patient: Amiodarone 200 mg p.o. B.I.D. and Ondansetron 2 mg IV every 12 hours. Note the severe interaction warning. Note that the warning cannot be altered by the end user. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our Drug/Drug and Drug/Allergy interaction checking test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 two (2) tasks to complete relating to CPOE Medication Allergy and Drug/Drug Interaction Alerts.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 172.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|---|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)4 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Note drug/ allergy alert | | 100% | 1.27 | 50.73 sec | 84.6% | 1.60 | 4.00 |
| Note drug/drug interaction alert | | 100% | 1.07 | 62.00 sec | 82.7% | 0.60 | 4.40 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - The drug/allergy alert is reliable and provides an added safety measure to the system, eliminating reliance on manually checking patient allergies.
 - The drug/drug interaction program and subsequent end user alert provides evidence-based clinical decision support for the prescriber or nurse transcribing the telephone order. This is a very positive system attribute.
 - Displaying the ‘conflict’ alert (for both of these tests) within the order links the user response to the alerts and maintains them at the order level. This is a positive feature.
 - Displaying the level of severity, onset and link to the evidence for drug/drug interactions was an added bonus beyond simply getting notification of the interaction.
 - Safety of this application is further enhanced by the fact that the alerts can only be added/modified by system administrators. End users conducting this test were required to respond to the alerts, and could not modify/delete them in any way.

AREAS FOR IMPROVEMENT

- There were no recommendations from the participants regarding improvement for either of these programs. The notifications, both for patient allergies and for drug/drug interactions were clearly presented and had good usability.

EFFECTIVENESS

Overall it was found that the effectiveness of these alerts satisfied their intended purpose. The risk of ordering a medication to which the patient has reported an allergy is reduced significantly to almost 0. Users do not have to manually check an allergy list and are reassured that the checking will occur 'behind the scenes' providing an alert when required.

Whether a provider is entering an order or an order is being transcribed as a telephone order by a nurse, the risk of placing an order for medications which have documented interactions is very high. This knowledge is best maintained in a knowledge-base that works seamlessly with the CPOE system. In addition to checking and reporting the drug/drug interactions, the severity level, onset of symptoms and links to the evidence are embedded in the alert as well. This is a very valuable and effective Clinical Decision Support tool.

EFFICIENCY

The efficiency of this application based on time –

Drug/Allergy Alert – the optimal time in which to complete this task was determined to be 60 seconds. The average time as demonstrated during the test was 50.7 seconds.

Drug/Drug Interaction Alert – the optimal time for this task was determined to be 75 seconds. The average time as demonstrated during the test was 62 seconds.

Efficiency of this application based on path deviations (number of clicks) -

Drug/Allergy Alert – the optimal number of clicks for this task was determined to be 6. The average number of clicks demonstrated during the test was 7.6.

Drug/Drug Interaction Alert – the optimal number of clicks for this task was determined to be 9. The average number of clicks demonstrated during this test was 9.6

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Drug Alert options is as follows:

| | |
|-----------------------------|-----|
| Drug/Allergy Alert | 4.0 |
| Drug/Drug Interaction Alert | 4.4 |

Participant comments overall reflected a high satisfaction rate with the Allergy and Interaction alerts, as noted in the following quotes collected from the follow up forms:

“It is very reassuring how the CPOE program alerts us to allergies.”

“It is a very good program, and informative.”

“Easy to understand – helpful pop-ups.”

“Straight forward – no difficulties.”

“Knowing the severity of the reactions was great extra information.”

“Very helpful to show drug reaction alerts.”

EHR Usability Test Report -170.315(g)(3)

170.315(a)5 – Demographics

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Demographics 170.315(a)5

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

STL Contact Person, Title and Affiliation: Deborah Ross, Clinical Analyst

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EXECUTIVE SUMMARY

A usability test of the Demographic information entry and editing application in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data and user reactions to multiple Demographic editing functions built into the EHRUT.

- Enter and change patient's ethnicity and sexual preference
- Enter and change patient's smoking status
- Record patient date and cause of death

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)5 is listed in the RESULTS section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315(a)5 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter & Change Smoking Status | 15 | | | | | | |
| Enter and change patient Ethnicity and Sexual Preference | 15 | | | | | | |
| Enter Cause and Date of Death | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study was the Demographic entry and modification screen in WebHIS 2.0. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- ***Enter patient's ethnicity as Cuban and change to Puerto Rican; enter patient's sexual preference as 'straight' or 'heterosexual' and change to 'choose not to disclose'.***
- ***Enter patient's smoking status as 'current everyday smoker' then change to 'former smoker'***
- ***Enter patient's cause of death as 'cardio-pulmonary' arrest and enter current date as date of death.***

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.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital’s simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate

23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department **Desktop Support Division**, according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task (a)5 Demographic Information – Adding and modifying patient Ethnicity and Sexual Preference |
| Task | <i>In patient demographics, enter your patient’s ethnicity as Cuban and save. Edit ethnicity to Puerto Rican. Enter patient’s sexual preference as ‘straight or heterosexual’ and save, then change to ‘choose not to disclose’.</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task (a)5 Demographic Information – Smoking Status |
| Task | Enter the patient’s smoking status as ‘current everyday smoker’ and save it. Enter the demographic tab and modify the smoking status to ‘former smoker’ and save. Review the current smoking status. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task (a)5 Demographic Information – Cause and date of death |
| Task | <i>In patient demographics, enter your patient's cause of death to 'cardio-pulmonary arrest' with the date of today.</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
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| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. The Demographics entry and editing test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks to complete relating to Demographics.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 172.315(a)5 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|--|----|-----------------|----------------------------------|-----------------------|----------------------------------|--------------|-----------------------------|
| Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) (sec) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter/change ethnicity and sexual preference | 15 | 100% | 1.10 | 47.7 | 79.4% | 0.87 | 4.33 |
| Enter and Change smoking status | 15 | 100% | 0.36 | 32.9 | 82.3% | 0.27 | 4.40 |
| Enter cause and date of death | 15 | 100% | 1.10 | 34.5 | 86.2% | 0.60 | 4.33 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - Both the entering and the editing of information was simple to use.
 - The initial 'Edit' link was not obvious in the WebHIS 2.0 screen as it is in other parts of this system.
 - The 'Save' button was not obvious to an untrained user – both the position and the size/color blended in to the screen background and made it more difficult to locate.

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Modify the current 'edit' link to a more obvious user-facing button.
 - Reposition and redesign the 'save' button to make it more obvious to the user. It is not located in an area of the screen in which a Save button would typically be positioned.

EFFECTIVENESS

Overall it was found that the effectiveness of the demographic functionality – entering, modifying and saving demographic information, was very high, based on both participant satisfaction as well as the overall System Usability Scale score. The recommended modifications will make the system more efficient but likely not more effective.

EFFICIENCY

Efficiency of this program based on time:

Smoking status - the optimal time for this task was determined to be 40 seconds. The average time needed as demonstrated during the test was 32.9 seconds.

Race and Ethnicity – the optimal time for this task was determined to be 60 seconds. The average time needed as demonstrated during the test was 47.7 seconds.

Cause of Death – the optimal time for this task was determined to be 40 seconds. The average time needed as demonstrated during the test was 34.5 seconds.

Efficiency of this program based on path deviation:

Smoking status – the optimal number of clicks for this task was determined to be 6. The average number of clicks as demonstrated during the test was 6.3.

Race and Ethnicity – the optimal number of clicks for this task was determined to be 8. The average number of clicks as demonstrated during the test was 8.9.

Cause of Death – the optimal number of clicks for this task was determined to be 6. The average number of clicks as demonstrated during the test was 6.6.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being ‘very easy’ to 1 being ‘very difficult’, the average user rating for each of the Demographic options is as follows:

| | |
|---------------------------------|-----|
| Enter and Change Smoking Status | 4.4 |
| Enter and Change Ethnicity | 4.3 |
| Enter date and cause of death | 4.3 |

Participant comments overall reflected a high satisfaction rate with the Demographic entry and editing screens, as noted in the following quotes collected from the follow up forms:

“Easy to use, but the long list of ethnicities was a bit confusing.”

“Simple drop down choices in several categories.”

“It took me a little longer to locate the ‘save’ button, but once I found it the rest of the screens were simple.”

EHR Usability Test Report – Holy Name Medical Center

170.315(g)(3) - Safety Enhanced Design
Review/Update/Edit Patient Problem List (a)6

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Patient Problem List 170.315(a)6

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

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EXECUTIVE SUMMARY

A usability test of the WebHIS Patient Problem List maintenance and review was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data on three (3) tasks typically conducted on an EHR:

- Add problems to the patient problem list
- Deactivate one of the current active problems
- Review and validate the resulting problem list

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

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

The summary data collected for **170.315(a)6** is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315g(3) | N | Task Successes | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---------------------------------|----|-------------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Patient Problem List (a)6 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter patient problems | 15 | | | | | | |
| Deactivate 1 problem | 15 | | | | | | |
| Review resulting Problem list | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study was the Problem List Maintenance and Review in WebHIS 2.0. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

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 the same 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

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

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- ***Enter the problems 'pressure ulcer' (399912005) and 'pneumonia' (233604007)***
- ***Inactivate the 'pneumonia' problem***
- ***Validate the list for accuracy – identify the appropriate active and inactive problems***

Tasks were selected based on their frequency of use and criticality of function. Tasks should always be constructed in light of the study objectives.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital's simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department **Desktop Support Division**, according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Objective Test Data Forms for 170.315(a)6

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task (a)6 Enter 2 problems as SNOMED codes to Patient Problem List |
| Task | Enter the following problems for your patient: Pressure Ulcer (399912005) and Pneumonia (233604007) |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task (a)6 While still in the Problem List screen, inactivate a single problem |
| Task | Inactivate the Pneumonia problem |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task (a)6 Review problem list |
| Task | Review all lifetime problems and record active and inactive problems and verify validity based on exercises 1 and 2 |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our Problem List update and review test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks to complete relating to Patient Problem List.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|--------------------------------|----|-----------------|--------------------------------|--------------|--------------------------------|--------------|-----------------------------|
| Task Problem List (a)(6) | # | Mean (SD) | Deviations Observed/Optimal | Mean (SD) | Deviations Observed/Optimal | Mean (SD) | Mean |
| Enter 2 problems | 15 | 100% | 1.13 | 131 sec | 87.33 % | 1.13 | 4.00 |
| Inactivate 1 problem | 15 | 100% | 1.18 | 25 sec | 71.43% | 0.53 | 4.13 |
| Review/Record Problems | 15 | 100% | 1.33 | 25.7 sec | 73.52% | 1.0 | 4.27 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - The problem list search returns multiple entries for a single problem. This is a function of the database used for the code search but was confusing to several users.
 - Once the user is comfortable with the tool it is very straightforward and easy to use
 - Not all of the column headings are labeled – causing some user confusion
 - The search button label was not obvious that it would allow ‘adding’ a new problem, especially since there is also an UpToDate search field on the same screen.
 - Comprehensive training is required to guarantee success with this application.

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Change the label on the ‘search’ button to ‘add problem’
 - Add a heading to the ‘history’ column and tool tips over the plus sign to expand

- Include 'tool tips' to assist the user while working in this application
- Identify ways to filter the resulting list to minimize the 'similar' options

EFFECTIVENESS

Overall it was found that the effectiveness of the Problem List Maintenance and Review system was very high, based on both participant satisfaction as well as the overall System Usability Scale score. The recommended modifications will make the system more efficient but likely not more effective.

EFFICIENCY

The efficiency of this application based on time –

Adding a new Problem – the optimal time for this task was determined to be 150 seconds (2.5 minutes). The average time as demonstrated when evaluating the results of the testing was 131 seconds.

Deactivating an active Problem – the optimal time for this task was determined to be 35 seconds. The average time as demonstrated when evaluating the results of the testing was 25 seconds.

Reviewing the complete Problem list – the optimal time for this task was determined to be 35 seconds. The average time as demonstrated when evaluating the results of the testing was 25.7 seconds.

Efficiency of this application based on path deviations (number of clicks) -

Adding a new Problem - the optimal number of clicks for this task was determined to be 9. The average number of clicks demonstrated during the test was 11.6. This confirmed that the comments recorded by the participants did cause significant path deviations, although did not significantly impact the time for successfully completing this task.

Deactivating a Problem - the optimal number of clicks for this task was determined to be 3. The average number of clicks demonstrated during the test was 3.53.

Reviewing all problems - the optimal number of clicks for this task was determined to be 2. The average number of clicks demonstrated during this test was 2.67

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Radiology tasks is as follows:

| | |
|---|------|
| Problem List – Enter Problems | 4.00 |
| Problem List – Inactivate one problem | 4.13 |
| Problem List - Review and Validate Problem list | 4.27 |

Participant comments overall reflected a very high satisfaction rate with the Problem List Maintenance system, as noted in the following quotes collected from the follow up forms:

“Once I understood where to click this became a very easy and useful program”.

“I’ve tried it and it is super easy”.

EHR Usability Test Report

170.315(g)(3) Safety Enhanced Design

Medication List (a)7

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Medication List

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

Date of Usability Test: July 30, 2019

Date Usability Test was Conducted: July 30, 2019

Date Report was Prepared: August 2, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

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EXECUTIVE SUMMARY

A usability test of the Medication List application in WebHIS 2.0 was conducted during the week of July 29, 2019 in Teaneck, New Jersey by Holy Name Medical Center. 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, ten (10) healthcare providers matching the target demographic criteria (Pharmacists) served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data on three (3) tasks typically conducted on an EHR:

- Add the medication Metoprolol Tartrate, 50 mg, p.o. q12h, hold if heart rate < 55
- Modify the above order to 25mg, p.o. q8h, hold if heart rate <55
- Review the patient's Medication Administration Record to confirm correct display and audit trail of all actions

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)7 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315g(3) | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|--|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)7 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Add a new medication to the MAR (med list) | 10 | | | | | | |
| Change elements of the above order | 10 | | | | | | |
| Review medication list | 10 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **76%**. This scale was provided to each participant only one time at the end of all of the tests.

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study utilized the Medication Profiling system in WebHIS 2.0, and RUMBA. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of ten (10) participants were tested on the EHRUT. Participants in the test were Staff Pharmacists, Clinical Pharmacy Specialists and Pharmacy Informaticists. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|---|------------------------------|--------------------------|-------------------------|----------------------------|
| 16 | ID01 | Female | 30-39 | Doctorate Degree | Clinical Pharmacy Specialist- Informatics | 84 | 252 | 36 | - |
| 17 | ID02 | Female | 40-49 | Doctorate Degree | Staff Pharmacist | 144 | 300 | 132 | - |
| 18 | ID03 | Male | 30-39 | Doctorate Degree | Clin.Pharmacy Specialist | 84 | 300 | 120 | - |
| 19 | ID04 | Male | 20-29 | Doctorate Degree | Clin Pharmacy Specialist Oncology | 24 | 240 | 24 | - |
| 20 | ID05 | Female | 20-29 | Doctorate Degree | Staff Pharmacist | 12 | 168 | 12 | - |
| 21 | ID06 | Female | 60-69 | Bachelor's Degree | Staff Pharmacist | 480 | 360 | 120 | - |
| 22 | ID07 | Female | 30-39 | Bachelor's Degree | Staff Pharmacist | 54 | 336 | 30 | - |
| 23 | ID08 | Male | 20-29 | Doctorate Degree | Staff Pharmacist Oncology | 30 | 240 | 30 | - |
| 24 | ID09 | Male | 30-39 | Doctorate Degree | Pharmacy Operations Manager | 108 | 324 | 192 | - |
| 25 | ID10 | Male | 50-59 | Bachelor's Degree | Manager Outpatient Pharmacy Services | 396 | 360 | 192 | - |

Ten (10) participants (matching the demographics in the section on Participants) were recruited and ten (10) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for a twenty (20) minute session to complete this test.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, as follows:

- ***Profile an order for Metoprolol Tartrate 50 mg every 12 hours, hold for a heart rate less than 55.***
- ***Modify the above order to Metoprolol Tartrate 25 mg every 8 hours, hold for a heart rate less than 55.***
- ***Review the patient’s medication list and identify the profiled medication and history of modifications***

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.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital’s simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department '**Desktop Support Division**', according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 7(a) Medication List |
| Task | Profile the medication Metoprolol Tartrate 50 mg PO q12 hours; hold for heart rate less than 55. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 7(a) Medication List |
| Task | Modify the above order to Metoprolol Tartrate 25mg every 8 hours; hold for heart rate less than 55. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Patient List Task 7(a) Medication List |
| Task | <i>View Medication list and identify newly added/modified medications</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our Medication List test session today will last for 20 minutes. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks to complete relating to creating, modifying and reviewing a patient’s Medication List.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 172.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|---|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| Task (a)7 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Enter new medication into medication list | | 100% | 1.11 | 48.20 | 64.27% | 1.10 | 4.20 |
| Modify the above medication | | 100% | 1.23 | 33.00 | 66.00% | 2.30 | 3.90 |
| Review the medication list | | 100% | 1.00 | 21.70 | 43.40% | 0 | 4.70 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - Difficult to work through the screens without prior training
 - Too many redundant clicks
 - Some users stated that it was easy to figure out but involved too many clicks
 - Adding parameters for orders was time consuming
 - Function keys should be defined on the screen
 - WebMAR is not user friendly – no legend, etc. apparent to users
 - No functionality to edit a medication – must either copy or enter an entirely new order
 - Copy function does not do interaction checking

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Add legend for function keys to RXO program
 - Add full function order modification program – including interaction checking
 - Streamline functionality to decrease number of clicks

EFFECTIVENESS

Overall it was determined that the effectiveness of the Medication List program (building and modifying the medication list) was high in the respect that the lists were built accurately but as evident from the participants' comments the process was time consuming and redundant.

EFFICIENCY

The efficiency of this application based on time –

Enter a new medication order – the optimal time in which to complete this task was calculated to be 75 seconds. The average time required to complete this task as demonstrated during the test was 48.2 seconds.

Modify a medication order - the optimal time for this task was determined to be 50 seconds. The average time required to complete this test was 33 seconds.

Review the medication list - the optimal time for this task was determined to be 50 seconds. The average time required to complete this test was 21.70 seconds.

Efficiency of this application based on path deviations (number of clicks) -

Enter a new medication order - the optimal number of clicks for this task was determined to be 10. The average number of clicks required to perform this function as demonstrated during the test was 11.1.

Modify a medication order – the optimal number of clicks for this task was determined to be 10. The average number of clicks required to perform this function as demonstrated during this test was 12.3.

Review the medication list - the optimal number of clicks for this task was determined to be 6. The average number of clicks required to perform this function as demonstrated during this test was 6.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Drug Alert options is as follows:

| | |
|-------------------------------------|------|
| Adding (profiling) a new Medication | 4.20 |
| Modifying a Medication | 3.90 |
| Reviewing Medication | 4.70 |

Participant comments reflected a mixed satisfaction rate with the Medication profiling and modification program, as noted in the following quotes collected from the follow up forms:

"The system is easy to figure out but it requires many redundant 'clicks'"

“There is no functionality that allows order modification - it is too time consuming and requires changes. We must enter a new order for most modifications.”

“The tasks assigned were clear and simple.”

“We have to work between systems in order to view the final medication list. This is not efficient and we aren’t familiar with that system.”

“Please add more prompts to the screens in these programs.”

EHR Usability Test Report – 170.315(g)(3) Safety Enhanced Design Medication Allergy List (a)8

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Medication Allergy List(a)8

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

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EXECUTIVE SUMMARY

A usability test of the Medication Allergy List program in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data and user reactions to multiple tasks related to documenting and retrieving information regarding a client's medication allergy list:

- Record a Medication Allergy
- Change a Medication Allergy
- Access and display the current Medication Allergy List

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)8 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|--------------------------------------|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| (a)8 Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Record Medication Allergy | 15 | | | | | | |
| Change Medication Allergy | 15 | | | | | | |
| Access Medication Allergy List | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study were the various tasks associated with recording, updating and reviewing a patient’s Medication Allergies in WebHIS 2.0.

Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset

systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, including but not limited to:

- ***Documenting a newly identified Medication Allergy***
- ***Updating the status of a currently documented Medication Allergy***
- ***Reviewing the complete list of active and inactive patient Medication Allergies***

These are realistic scenarios that are used during procedures and surgeries on a daily basis, whether implanting or removing a said device, implant or prosthetic.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital's simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse, keyboard and barcode scanner when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor
Ds8100-HC Series Handheld Imager (for barcode scanning)

The application was set up by the Holy Name Medical Center Information Systems department **Desktop Support Division**, according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 175.310(a)8 Medication Allergy List |
| Task | <i>Record the allergy 'penicillin' for your patient with reaction 'shock'</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)8 Medication Allergy List |
| Task | <i>Inactivate the penicillin allergy for your patient</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)8 – Patient Allergy List |
| Task | Review the list of active and inactive medication allergies for your patient. Note the allergy that you added and updated. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. The Medication Allergy test session today will last for twenty minutes with a five minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you have general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks within the Medication Allergy program to complete and evaluate.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| (a)14 Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Record Medication Allergy | 15 | 100% | 1.16 | 28.1 sec | 70.2% | 1.4 | 4.13 |
| Change the Medication Allergy Status | 15 | 100% | 1.25 | 20.6 sec | 68.7% | 1.27 | 4.20 |
| Review the complete Medication Allergy List | 15 | 100% | 1.30 | 19.4 sec | 77.6% | 1.20 | 4.20 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

➤ Major Findings –

- The ‘maintain allergies’ button was not descriptive to the tasks it represents
- The medication search took a while to respond removal, which is a mandatory
- The medication search returns too many options for each substance – it should only return one response per medication name.
- When viewing the initial list there is no way to view the audit trail and history – the user must go to the ‘maintain allergies’ view.

AREAS FOR IMPROVEMENT

➤ Areas for Improvement

- Change the 'Maintain Allergies' label to read 'Add/Edit Allergies'
- Make that button a different color to draw the user to it
- Include a toggle for 'History' (the audit trail) on the initial view and all subsequent views
- Reduce the medication list to one instance for each substance – additional forms are redundant in this application. This will speed up the search significantly.

EFFECTIVENESS

Overall it was found that the effectiveness of the Medication Allergy program was high. Although users did make valuable observations and recommendations regarding the User Interface, the application itself captures and displays current and inactive medication allergies and alerts patients to said allergies in applications where the information is needed for patient safety and clinical decision support, such as in CPOE. With some minor cosmetic changes as recommended above this application will continue to support patient safety and be easy to use.

EFFICIENCY

The efficiency of this application based on time –

Enter new medication allergy – the optimal time for this task was determined to be 40 seconds. The average time as demonstrated during the test was 28.1 seconds.

Modify the medication allergy – the optimal time for this task was determined to be 30 seconds. The average time as demonstrated during the test was 20.6 seconds.

Review the list of current and deactivated medication allergies – the optimal time for this task was determined to be 25 seconds. The average time as demonstrated during the test was 19.4 seconds.

Efficiency of this application based on path deviations (number of clicks) -

Enter new medication allergy – the optimal number of clicks for this task was determined to be 9. The average number of clicks demonstrated during the test was 10.4.

Modify the medication allergy – the optimal number of clicks for this task was determined to be 5. The average number of clicks demonstrated during this test was 6.27.

Review the list of current and deactivated medication allergies – the optimal number of clicks for this task was determined to be 4. The average number of clicks demonstrated during this test was 5.2.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Clinical Decision Support Rules was as follows:

| | |
|---|-------------|
| Adding Medication Allergy | 4.13 |
| Change the status of the Allergy | 4.20 |
| Review Patient Allergy List | 4.20 |

PARTICIPANT COMMENTS

Participant comments overall reflected a high satisfaction rate with the Medication Allergy application, as noted in the following quotes collected from the follow up forms:

“Easy and straight forward”

“Easy and intuitive to use”

“Easy to navigate – will be easier if some of the buttons are renamed”

“If the medication list is shorter this will be faster to use, but overall it was easy and intuitive”

EHR Usability Test Report

170.315(g)3 Safety Enhanced Design

Clinical Decision Support-(a)9

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Clinical Decision Support 170.315(a)9

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

Date of Usability Test: December 6, 2018
Date Usability Test was Conducted: December 6, 2018
Date Report was Prepared: April 15, 2019
Report Prepared by: Deborah Ross
Name of System Test Laboratory (STL): Holy Name Medical Center
STL Contact Person, Title and Affiliation: Deborah Ross, Clinical Analyst
STL Phone Number: 201-833-7114
STL Email Address: debross@mail.holyname.org
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EXECUTIVE SUMMARY

A usability test of multiple Clinical Decision Support (CDS) rules in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data and user reactions to multiple Clinical Decision Support rules built into the EHRUT, as follows:

- Trigger CDS interventions using demographic information
- Trigger CDS Interventions using vital signs data elements
- Trigger CDS interventions using medication allergies
- Trigger CDS interventions using lab data
- Trigger CDS intervention based on a patient problem
- Trigger CDS interventions using combination data – lab and demographic – diabetes consult
- Access diagnostic and therapeutic reference information using the Infobutton for data elements in the problem list, medication list and demographics
- Access the following attributes for a CDS intervention: bibliographic citation, developer, funding source, release/revision date

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant’s satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)9 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 172.315(g)3 | N | Task Success | Path Deviation Deviations (Observed/Optimal) | Task Time | | Errors Mean (SD) | Task Ratings (5=Easy) Mean (SD) |
|---|----|-----------------|--|--------------|----------------------------------|------------------------|--|
| | | | | Mean (SD) | Deviations (Observed/Optimal) | | |
| Clinical Decision Support (a)9 | # | Mean (SD) | | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Demographic alert – MMR <2 yo | 15 | | | | | | |
| Vital signs-BMI <19 | 15 | | | | | | |
| Lab value – LDL >70 | 15 | | | | | | |
| Problem list- AMI | 15 | | | | | | |
| Combination - Lab and Vitals | 15 | | | | | | |
| Medication allergy-Isovue | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study was a sampling of Clinical Decision Support rules that are currently active in the WebHIS 2.0. Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

The objective of this test was to uncover areas where the application performed 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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, including but not limited to:

- ***Reacting to prompts and reminders recommending actions based on patient vital signs, laboratory results, demographics, medication allergies, problems and a combination of multiple factors.***
- ***Viewing the evidence supporting these actions***

Clinical Decision Support rules were developed and tested based on their frequency of use and universality and criticality of function. Tasks should always be constructed in light of the study objectives.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital’s simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department **Desktop Support Division**, according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 175.310(a)9 Clinical Decision Support – Trigger demographic alert |
| Task | When a practitioner accesses CPOE for the first time on a patient 2 years of age or younger an MMR immunization reminder will be launched. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

Title: Rationale for assessing/administering MMR vaccine for patients 2 years of age and younger.

- Abstract: Upon admission of a pediatric patient ≤ 2 years of age, a prompt will launch when the provider access CPOE reminding the provider to review the patient's immunization status and consider administering an MMR vaccine during the patient's stay if the patient is not up to date on his/her vaccines.
- Bibliographic citation: <https://www.uptodate.com/contents/2876#H2115055251>
- Developers: Adam Jarrett, MD, Deb Zayas, RN
- Funding source: Internally funded
- Release: Version 1.0, November, 2013
- Review/Revision Date: November 2017 (no revisions made)


Holy Name Clinical Decision Support

Patient: Act#: MR#:

- Patient age indicates that they may be due for their first dose of the MMR vaccine. Please assess patient vaccine status. #13

Responses

- Medical contraindication
- I will order the vaccine
- Other:

 [Click here](#) to view UptoDate guidance

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)9 Clinical Decision Support – Laboratory Tests and Results |
| Task | <i>When a patient with an LDL value >70 is being discharged launch a prompt for the practitioner to consider prescribing a statin.</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

Rationale for ordering a statin at discharge if patient's LDL > 70.


This intervention occurs when accessing the discharge Medication Reconciliation program.

- Abstract: To minimize the risk of stroke, the Physician will be prompted to order a Statin upon discharge of an adult patient with a documented LDL > 70, or document a valid reason for overriding the prompt.
- Bibliographic citation (clinical research/guidelines)
https://www.uptodate.com/contents/screening-for-lipid-disorders-in-adults?search=screening%20for%20lipid%20disorders%20in%20adults&source=search_result&electedTitle=1~150&usage_type=default&display_rank=1
- Developer: Adam Jarrett, MD,
- Funding source: Internally funded
- Release: Version 1.0, November 2013
- Reviewed/Revised: December 2017

Holy Name Clinical Decision Support

Patient: Act#: MR#:

- The patient has had a confirmed LDL level > 70. Please order a statin on discharge unless contraindicated, in which case please document the contraindication. #11

 [Click here to view UptoDate guidance](#)

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)9 Clinical Decision Support – Vital Signs |
| Task | If an adult patient has a BMI <19 a consultation with a dietitian and a Calorie Count will be recommended upon initially accessing CPOE. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |


Rationale for prevention of complications in patients with a documented low BMI:

- Abstract: Weight and height are recorded for each patient upon admission to the hospital and BMI is calculated. To lower the risk of complications both a Dietitian Consult and a Calorie Count should be ordered for each adult patient with a recorded BMI < 19.
- Bibliographic citation/guideline:
https://www.uptodate.com/contents/dietary-assessment-in-adults?search=dietary%20assessment%20in%20adults&source=search_result&selectedTitle=2~150&usage_type=default&display_rank=2
- Developer: Janet Post, RN
- Funding source: Internally funded
- Release 1.0
- Review/Revised: Reviewed 10/2018

Holy Name Clinical Decision Support

Patient: Act#: MR#:

- Patient BMI is <19 and may be at risk of malnutrition. Please consider ordering a dietary consultation and caloric count

 [Click here to view UptoDate guidance](#)

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)9 Clinical Decision Support – Medication Allergy List |
| Task | A warning regarding ordering tests using contrast will launch in CPOE on patients with a recorded allergy to ISOVUE. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

Title: Rationale for Alert when ordering CT with contrast on patients with Isovue allergies


- Abstract: Upon ordering a diagnostic CT scan with contrast on a patient with a documented allergy to Isovue, the provider will be prompted to consider alternative orders not using contrast or to order pre-medication to minimize the likelihood of reaction to the contrast medium.
- Bibliographic guideline/UpToDate source:
- https://www.uptodate.com/contents/diagnosis-and-treatment-of-an-acute-reaction-to-a-radiologic-contrast-agent?search=immediate%20hypersensitivity%20reactions%20to%20radiocontrast%20media%20prevention%20of%20recurrent%20reactions&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1
- Developer: Sheryl Fall, RN
- Funding source: Internally funded
- Release: Version 1.0, October 2013
- Revision date: Reviewed, September 2018. No revisions.

Holy Name Clinical Decision Support

Patient: Act# MR#:

☐

- Please note: Your patient has stated an allergy to contrast (ISOVUE). If ordering a diagnostic test requiring contrast consider ordering the appropriate pre-medication as well.

 [Click here to view UpToDate guidance](#)

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)9 Clinical Decision Support – Problem List |
| Task | If patient has a recorded Acute Myocardial Infarction the practitioner is prompted to order Aspirin on creating discharge medication list. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

Title: **Rationale for Aspirin at discharge for AMI Patients**

- Abstract: If patient has been identified as having a documented AMI during this encounter, the practitioner will be prompted to order Aspirin upon discharge during the Medication Reconciliation process. If practitioner disagrees, a reason must be documented.
- Citation/bibliographic supporting data can be found at:
https://www.uptodate.com/contents/overview-of-the-prevention-of-cardiovascular-disease-events-in-those-with-established-disease-secondary-prevention-or-at-high-risk?search=aspirin%20at%20discharge%20of%20patient%20with%20AMI&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1
- Developer: Adam Jarrett, MD, Janet Grotzky, RN
- Funding source: Internally funded
- Release: Version 1.0, November, 2013
- Reviewed/Revised: March, 2018

Holy Name Clinical Decision Support

| | | | |
|----------|-------|------|--|
| Patient: | Act#: | MR#: | |
|----------|-------|------|--|

• Your patient has a confirmed diagnosis of Acute Myocardial Infarction. Please consider aspirin daily upon discharge unless otherwise indicated.

Responses


I will add this to discharge med list

Patient Allergic/Intolerant

Medical contraindication

Patient Refused

Other:

 [Click here to view UptoDate guidance](#)

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)9 Clinical Decision Support – Combination |
| Task | If patient has a BMI >30 and a recorded elevated Hemoglobin A1C an alert recommending a Diabetes Nurse Consult in CPOE is launched. |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |


Title: **Rationale for Recommending a Diabetes Nurse Consult for patients with elevated HgA1C and BMI >30**

- Abstract: Type 2 Diabetes (T2D) is often gradual and preceded by impaired glucose homeostasis. Lifestyle interventions including weight loss, improved nutritional habits and increased activity may reduce the risk of developing T2D. Adhering to lifestyle changes can be challenging. Management of prediabetes is highly relevant considering that between 29% and 93% of individuals with prediabetes will develop T2D in the years following their diagnosis. Data also suggests lifestyle intervention could decrease the risk of prediabetes progressing to T2D for as long as 10 years. Education and guidance by a professional is supportive of these lifestyle changes.
- Citation/bibliographic supporting data can be found at:
- https://www.uptodate.com/contents/risk-factors-for-type-2-diabetes-mellitus?search=risk%20factor%20for%20type%20diabetes%20mellitus&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1
- Developer: Michele Acito, MSN, RN, NE-BC, NP-C
- Funding source: Internally funded
- Release: Version 1.0, November, 2018

Holy Name Clinical Decision Support

Patient: Act#: MR#:

- Your patient is at high risk for diabetes based on their elevated HgA1C value and BMI >30. A diabetes nurse consult is recommended.

 [Click here](#) to view UptoDate guidance

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. Our Clinical Decision Support Rules test session today will last for 20 minutes with a 5 minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 six (6) tasks to complete which will launch Clinical Decision Support rules.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|--|----|-----------------|----------------------------------|-----------------------|----------------------------------|--------------|-----------------------------|
| | | | | Mean (SD) | Deviations (Observed/Optimal) | | |
| Clinical Decision Support (a)9 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) (sec) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Demographic alert –MMR < 2 yo | 15 | 100% | 1.03 | 13.2 | 88% | 0.07 | 4.73 |
| Vital signs BMI <19 | 15 | 100% | 1.03 | 12.6 | 84% | 0.07 | 4.73 |
| Lab Values LDL >70 | 15 | 100% | 1.13 | 12.3 | 82% | 0.27 | 4.53 |
| Medication allergy- isovue | 15 | 100% | 1.07 | 11.7 | 78% | 0.13 | 4.67 |
| Problem list- AMI | 15 | 100% | 1.20 | 12.2 | 81% | 0.4 | 4.53 |
| Combination- problem (lab) and Vitals (BMI) | 15 | 100% | 1.07 | 11.5 | 76% | 0.13 | 4.53 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Major Findings –
 - All rules were simple to understand and were valuable and supported patient safety and efficiency
 - Several rules did not have options to document the next action taken
 - Rules involving aspirin did not have an alert if patient had a documented allergy to aspirin
 - The ‘isovue’ allergy would have been less of a distraction if it only appeared when a test with contrast was actually being ordered and not at the CPOE level (rather than order level) as it currently does.

- Functions involving CPOE orders would have added value if they automatically added the order to the order 'basket' and allowed the user to delete it from their order basket if not wanted/needed.
- Functions involving discharge medications did not add the medications to the patient's discharge medication list when selected.
- The tab on the Patient Dashboard used for discharge medications is not obvious. It is currently labeled 'Rx' but there is also a tab labeled 'Med'. These two buttons cause confusion for the user.

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Include a medication allergy alert for any CDS rule that recommends ordering specific medication as follow up
 - Add response options to CDS rules that only had an 'acknowledge' button with no follow up actions listed
 - Add allergy alerts to specific orders (as for medication ordering) rather than at the initiation of the CPOE process.
 - Update the tab name that includes creating a discharge medication list to include indication of functionality. Currently it is labeled only 'Rx'.
 - Analyze the possibility of launching a 'pending' order into the order basket for recommended orders, if selected by practitioner.
 - Analyze the possibility of adding the recommended discharge medication to the patient's discharge medication list as a pending medication, requiring details or deletion by practitioner when completing the list.

EFFECTIVENESS

Overall it was determined that the effectiveness of each of the Clinical Decision Support alerts is high. Each of these prompts creates a hard stop reminding the practitioner of a critical responsibility, which might easily be overlooked during very busy times. Especially on admission, when a practitioner might have little knowledge of the client (vital signs, allergies, demographics) as well as during the ordering and discharge processes, working fast is not always working 'smart'. These alerts, requiring a response, prompt the user to stop and make careful consideration of options based on documentation.

EFFICIENCY

The efficiency of this application based on time –

Viewing these alerts as a group, the average time for completing and responding to the alerts was between 75% and 88% of the optimal time, demonstrating highly efficient applications.

Efficiency of this application based on path deviations (number of clicks) -

Each of these alerts optimally required 2 clicks. The mean number of clicks among these six CDS rules ranged from 2.07 – 2.40, exhibiting a safe, efficient and simple to use and understand user interface.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Clinical Decision Support Rules was as follows:

| | |
|--------------------|-----|
| Demographic alert | 4.7 |
| Vital Signs | 4.7 |
| Laboratory values | 4.5 |
| Medication allergy | 4.7 |
| Problem List | 4.5 |
| Combination | 4.5 |

Participant comments overall reflected a high satisfaction rate with the Demographic entry and editing screens, as noted in the following quotes collected from the follow up forms:

“Informative and great reminder for busy physicians and other providers”

“Alerts are valuable – need to check and include the medication allergies”

“Including the UpToDate reference in the pop-up helps us to validate the response”

“Having to remember every bit of information on a patient, especially when preparing for discharge is a big responsibility. These alerts are supportive of optimal patient care and will help to prevent readmissions as well”.

EHR Usability Test Report

170.315(g)(3) Safety Enhanced Design

Implantable Devices (a)14

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – Implantable Devices 170.315(a)14

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

Date of Usability Test: December 6, 2018

Date Usability Test was Conducted: December 6, 2018

Date Report was Prepared: April 15, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

STL Contact Person, Title and Affiliation: Deborah Ross, Clinical Analyst

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EXECUTIVE SUMMARY

A usability test of the Implantable Device tracking application in WebHIS 2.0 was conducted on December 6, 2018, in Teaneck, New Jersey by Holy Name Medical Center. 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, fifteen (15) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

The study collected performance data and user reactions to multiple tasks related to documenting and retrieving information regarding Implantable Devices as follows:

- Record a Unique Device Identifier (UDI) and status for a new implant for your patient
- Change the status of the implant
- Access and identify UDIs, device description, UDI identifiers and status

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and they were instructed that they could withdraw from the test at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(a)14 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 170.315(g)3 (a)14 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---------------------------|----|--------------|-------------------------------|-----------|-------------------------------|-----------|-----------------------|
| Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Record UDI and status | 15 | | | | | | |
| Change status of implant | 15 | | | | | | |
| Access UDI attributes | 15 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **86 %**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study were the various tasks associated with documenting an Implantable Device using the Unique Device Identifier (UDI) and being able to update and retrieve that data in WebHIS 2.0.

Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of fifteen (15) participants were tested on the EHRUT. Participants in the test were staff nurses, nurses in clinical management, physicians and medical students. Participants work at Holy Name Medical Center in the clinical areas throughout the hospital. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|-------------------|-------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 1 | ID01 | Female | 30-39 | Bachelor's Degree | Staff RN | 12 | 180 | 12 | - |
| 2 | ID02 | Male | 20-29 | Bachelor's Degree | Staff RN | 60 | 150 | 6 | - |
| 3 | ID03 | Female | 60-69 | Master's Degree | Nursing Director | 420 | 360 | 120 | - |
| 4 | ID04 | Female | 20-29 | Bachelor's Degree | Medical Student | 0 | 130 | 1 | - |
| 5 | ID05 | Female | 40-49 | Bachelor's Degree | Staff RN | 84 | 240 | 84 | - |
| 6 | ID06 | Male | 30-39 | Doctorate Degree | Hospitalist | 156 | 240 | 36 | - |
| 7 | ID07 | Female | 40-49 | Associate Degree | Staff RN | 240 | 240 | 84 | - |
| 8 | ID08 | Male | 20-29 | Bachelor's Degree | Medical Student | 0 | 180 | 1 | - |
| 9 | ID09 | Female | 40-49 | Bachelor's Degree | Staff RN | 216 | 240 | 72 | - |
| 10 | ID10 | Female | 50-59 | Master's Degree | Staff RN | 420 | 200 | 72 | - |
| 11 | ID11 | Male | 40-49 | Doctorate Degree | Hospitalist | 182 | 192 | 36 | - |
| 12 | ID12 | Female | 60-69 | Associate Degree | Operating Room RN | 456 | 120 | 60 | - |
| 13 | ID13 | Female | 30-39 | Bachelor's Degree | Staff RN | 48 | 180 | 24 | - |
| 14 | ID14 | Female | 20-29 | Bachelor's Degree | Staff RN | 36 | 180 | 12 | - |
| 15 | ID15 | Female | 50-59 | Associate Degree | Staff RN | 324 | 240 | 96 | - |

Fifteen (15) participants (matching the demographics in the section on Participants) were recruited and fifteen (15) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for multiple fifteen (15) and twenty (20) minute sessions with five (5) minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset

systems to proper test conditions where required. A spreadsheet was used to keep track of the participant schedule, and included each participant's demographic characteristics.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in section on Usability Metrics.

TASKS

A number of tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, including but not limited to:

- ***Documenting an implanted device in a patient's record***
- ***Updating the status of a currently implanted device (removal)***
- ***Reviewing the complete list of devices including all detail***

These are realistic scenarios that are used during procedures and surgeries on a daily basis, whether implanting or removing a said device, implant or prosthetic.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

To ensure that the test ran smoothly, multiple staff members participated in this test – the administrator and several members of the hospital's simulation center, who are experienced test administrators/loggers and frequently participate in these types of exercises in our busy simulation training and testing center.

The administrator moderated the session including administering instructions and tasks. The administrator in conjunction with the data loggers monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital (inpatient unit, procedural area, clinic). In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse, keyboard and barcode scanner when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor
Ds8100-HC Series Handheld Imager (for barcode scanning)

The application was set up by the Holy Name Medical Center Information Systems department '**Desktop Support Division**', according to the vendor's documentation, describing the system set-up and preparation.

System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario
- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 175.310(a)14 Implantable Devices |
| Task | Record a new implanted device (UDI) and status |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)14 Implantable Devices |
| Task | <i>Change the status of the implanted device from implanted to removed</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 170.315(a)14 – Implantable Devices |
| Task | Review the list of implanted and removed devices and record |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

PARTICIPANT INSTRUCTIONS

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

*Thank you for participating in this study. Your input is very important. Our Implantable Device List test session today will last for twenty minutes with a five minute break after everyone has completed the exercises. During that time you will use an instance of an electronic health record. 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. **Note that you will be using a handheld barcode scanner during this exercise.***

Please note that we are not testing you, we are testing the system, therefore if you have difficulty with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 three (3) tasks within the Patient Implantable Device Maintenance program to complete and evaluate.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| (a)14 Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Record implanted device | 15 | 100% | 1.26 | 47 sec | 78.33% | 1.53 | 3.73 |
| Update removal of implanted device | 15 | 100% | 1.11 | 17.73 sec | 70.93% | 0.33 | 4.33 |
| Review active and removed devices | 15 | 100% | 1.17 | 19.07 sec | 76.27% | 0.67 | 4.27 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80% would be considered above average.

MAJOR FINDINGS

➤ Major Findings –

- Initial screen labels are not obvious to a new user – example – buttons for ‘UDI’s’ and ‘Free Text’
- The ‘Add’ button was initially difficult to find
- Prompts for scanning did not indicate which barcodes to scan
- After scanning the barcodes, there was no indication whether or not complete data was obtained; users stated they were able to save incomplete data
- The ‘remove’ button should be a contrasting color
- The full loop from insertion through removal (if applicable) worked well and provided a clear audit trail for each implant, including site, notes, status updates and reason for removal, which is a mandatory field.
- The detail screen is too large for the display area and the user must scroll down to see the Save button.

AREAS FOR IMPROVEMENT

- Areas for Improvement
 - Include 'tool tips' over each button
 - Move the 'Add' button to the left side of the screen where the other options are located
 - Colorize the 'Add' button in a color other than the rest of the buttons (gray)
 - Allow the user to scan additional barcodes and indicate when all necessary data is obtained and documented (create additional fields)
 - Highlight the 'remove' button to make it more obvious to the user
 - The system will indicate when it has captured all data, providing the user with the ability to decide whether or not to save the item
 - Condensing the 'add' screen to avoid scrolling to the Save button.

EFFECTIVENESS

Overall it was found that the effectiveness of the Implantable device tracking program was high. Although users did make valuable observations and recommendations regarding the User Interface, the application itself captures and displays current, inactive and removed implants in a clear manner. Based on this easy to use application, potential recalls would be very easy to manage, and requested reports will be easy to generate.

EFFICIENCY

The efficiency of this application based on time

Enter new implant – the optimal time for this task was determined to be 60 seconds. The average time as demonstrated during the test was 47 seconds.

Modify the implant status – the optimal time for this task was determined to be 25 seconds. The average time as demonstrated during the test was 18 seconds. (17.7)

Review implant data – the optimal time for this task was determined to be 25 seconds. The average time as demonstrated during the test was 19 seconds.

Efficiency of this application based on path deviations (number of clicks):

Enter new implant – the optimal number of clicks for this task was determined to be 6. The average number of clicks demonstrated during the test was 7.5.

Change the implant status – the optimal number of clicks for this task was determined to be 3. The average number of clicks demonstrated during this test was 3.3

Review implant data – The optimal number of clicks for this task was determined to be 4. The average number of clicks demonstrated during this

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for each of the Clinical Decision Support Rules was as follows:

| | |
|--|------------|
| Adding new implant (UDI) | 3.7 |
| Change the status of implant | 3.9 |
| Review patient history for all implants | 4.0 |

PARTICIPANT COMMENTS

Participant comments overall reflected a high satisfaction rate with the Implantable Device adding and editing screens, as noted in the following quotes collected from the follow up forms:

“Easy to collect and track important data”.

“I was easily able to add an implant to my patient’s record”.

“It is reassuring to know that we can retrieve this information whenever necessary”.

“This is a game-changer for those of us who work in the Operating Room where we implant devices on a daily basis. Thank you!”

EHR Usability Test Report – 170.315(g)(3) Safety Enhanced Design CCDA Reconciliation (b)2

UCD Process Used: NISTIR 7741:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7741) NIST, Guide to the Processes Approach for Improving the Usability of Electronic Health Records. NIST, 29 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7741.pdf>

Report Based on: NISTIR 7742:

Schumacher, Robert M., and Svetlana Z. Lowry. (NISTIR 7742) NIST, Customized Common Industry Format Template for Electronic Health Record Usability Testing. NIST, 16 Nov. 2010. Web. <https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7742.pdf>

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EHR USABILITY TEST REPORT – CCDA Import and Reconciliation (b)2

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

Date of Usability Test: July 16, 2019

Date Usability Test was Conducted: July 16, 2019

Date Report was Prepared: July 22, 2019

Report Prepared by: Deborah Ross

Name of System Test Laboratory (STL): Holy Name Medical Center

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EXECUTIVE SUMMARY

A usability test of the CCDA reconciliation program in WebHIS 2.0 was conducted on July 16, 2019, in Teaneck, New Jersey by Holy Name Medical Center. 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, ten (10) healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks. All of the participants were members of the Health Information Management Department, serving in various roles.

The study collected performance data and user reactions to multiple tasks related to matching and reconciling a patient's Continuity of Care Document (CCD) from an outside provider into the native WebHIS application.

- Access a Continuity of Care Document
- Identify and match to a patient
- Review and incorporate relevant data into the WebHIS 2.0 application

During the twenty (20) minute summative usability test, each participant was greeted by the administrator and instructed that they could withdraw from the exercise at any time. All participants had varying levels of 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 along with the logger(s) recorded user performance data on paper. The administrator did not give the participant assistance in 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 verbalizations
- Participant's satisfaction ratings of the system – LIKERT and System Usability Scale (SUS)

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. 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. The summary data collected for 170.315(b)2 is listed in the **RESULTS** section of this document. The following is the recommended template utilized when calculating the individual results:

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|----|-----------------|----------------------------------|--------------|----------------------------------|--------------|-----------------------------|
| (b)2 Task | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Retrieve, match and incorporate CCD data | 10 | | | | | | |

The overall results calculated from the **System Usability Scale (SUS)** provided to each participant scored the subjective satisfaction with the system based on performance with these tasks to be **89%**. This scale was provided to each participant **only one time at the end of all of the tests.**

In addition to the performance data, qualitative data including both major findings and areas for improvement, based on participant anecdotal feedback will be listed in the RESULTS section as well.

INTRODUCTION

The EHRUT tested for this study were the various tasks associated with recording, updating and reviewing a patient’s Medication Allergies in WebHIS 2.0.

Designed to present medical information to healthcare providers in the acute care setting at Holy Name Medical Center, the EHRUT is a clinical information system used by all staff who participate in the care of our patients, on a clinical, financial or record keeping level. 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 EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency, and user satisfaction were captured during the usability testing.

METHOD

PARTICIPANTS

A total of ten (10) participants were tested on this application in the EHRUT. Participants in the test were various members of the Health Information Management (HIM) team, including Clinical Documentation Specialists, Coders and Chart Abstracters. Participants work at Holy Name Medical Center. Participants did not participate in the requirements gathering, design or development of the EHRUT being tested. 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 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.

| | Participant ID | Gender | Age | Education | Occupation/ Role | Professional Experience (mo) | Computer Experience (mo) | Product Experience (mo) | Assistive Technology Needs |
|----|----------------|--------|-------|---|-----------------------------------|------------------------------|--------------------------|-------------------------|----------------------------|
| 26 | ID01 | F | 40-49 | High School graduate, diploma or the equivalent | Medical Records Q/A | 240 | 240 | 156 | N |
| 27 | ID02 | F | 60-69 | Bachelor’s Degree | Supervisor | 300 | 300 | 120 | N |
| 28 | ID03 | F | 60-69 | Trade/Technical/Vocational Training | HIM Associate | 336 | 336 | 156 | N |
| 29 | ID04 | F | 40-49 | Associate Degree | HIM Associate | 324 | 324 | 156 | N |
| 30 | ID05 | F | 60-69 | Master’s Degree | Clinical Documentation Supervisor | 444 | 240 | 108 | N |
| 31 | ID06 | F | 50-59 | Bachelor’s Degree | Clinical Documentation Specialist | 372 | 324 | 156 | N |
| 32 | ID07 | F | 30-39 | Associate Degree | Clinical Documentation Specialist | 228 | 240 | 156 | N |
| 33 | ID08 | F | 30-39 | Associate Degree | Clinical Documentation Specialist | 204 | 300 | 156 | N |
| 34 | ID09 | F | 60-69 | Trade/Technical/Vocational Training | HIM Associate | 480 | 240 | 84 | N |
| 35 | ID10 | M | 40-49 | Associate Degree | Outpatient Coder | 48 | 360 | 48 | N |

Ten (10) participants (matching the demographics in the section on Participants) were recruited and ten (10) participated in the usability test. Zero (0) participants failed to show for the study.

Participants were scheduled for a thirty (30) minute session. A spreadsheet was used to keep track of the participant schedule, and included each participant’s demographic characteristics.

STUDY DESIGN

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 the same 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

Additional information about the various measures can be found in the section on Usability Metrics.

TASKS

A composite task was designed that would be realistic and representative of the kinds of activities a user might do with this EHR, which included the following components:

- ***Retrieve a CCD from an outside practice***
- ***Match the patient demographics to that of a patient already in the native EMR (WebHIS)***
- ***Review and incorporate clinical data from the CCD into the native EMR (WebHIS)***

These are components of a realistic scenario that would occur on a daily basis beginning with the staff of the Health Information Management department.

PROCEDURES

Upon arrival, participants were greeted by the test administrator. Their identity was verified and matched with their name on the participant schedule. Participants were then assigned an anonymous participant ID.

This test was conducted on an individual basis – each participant performed the functions individually, with the administrator both describing and conducting the test.

The administrator moderated the session including administering instructions and tasks. The administrator monitored task times, obtained post-task rating data, and took notes on participant comments, in addition to taking 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. Scoring is discussed below.

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

TEST LOCATION

The test facility included a quiet computer training room with tables and a desktop computer for each participant. To ensure that the environment was comfortable for users, noise levels were kept to a minimum with the ambient temperature within a normal range. All of the safety instruction and evacuation procedures were valid, in place, reviewed with and visible to the participants.

TEST ENVIRONMENT

The EHRUT would typically be used in a hospital HIM department. In this instance, the testing was conducted in the same facility on computers that were set up the same way as the clinical areas of the hospital where the application will be used. The computer being used was an **IBMi Power 7 running I5OS v7.2**. The environment in which the testing was conducted was the WebHIS 2.0 User Acceptance Testing (UAT) environment.

The participants used a mouse and keyboard when interacting with the EHRUT. The following is the configuration of the PCs used both in the test environment as well as throughout the organization in the clinical areas where desktop PCs are used:

Windows 10, dual 2.70GHz IntelCore i5 processor
8GB RAM
1600 x 900 resolution
RGB color format, SDR Color Space
6-bit
60 Hz refresh rate
23 inch monitor

The application was set up by the Holy Name Medical Center Information Systems department '**Desktop Support Division**', according to the vendor's documentation, describing the system set-up and preparation. System performance (i.e., response time) on the UAT is typically slower than that of the live environment. This was considered when calculating optimal times into the parameters for testing. Additionally, participants were instructed to not change any of the default system settings (such as control of font size).

TEST FORMS AND TOOLS

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

- Participant demographic form
- Description of the test cases
- Objective test data capture form (for each test)
- Likert Scale for each test scenario

- System Usability Scale – one overall for each participant

Sample Objective Test Data Forms:

| | |
|-----------------------------|---|
| Task Performance Evaluation | WebHIS 2.0 Task 175.310(b)2 CCDA |
| Task | <i>Match, reconcile and incorporate a patient's CCD for Allergies, Meds and Problems</i> |
| Participant number | |
| Task Time (minutes:seconds) | |
| Task Success | <input type="checkbox"/> Easily Completed <input type="checkbox"/> Completed with difficulty <input type="checkbox"/> Not able to complete |
| Path Deviation | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Observed number of steps | |
| Number of errors | |
| Participants Verbalizations | |
| Major Findings | |
| Satisfaction Rating | <input type="checkbox"/> 1 Very Difficult <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Very Easy |
| | |

PARTICIPANT INSTRUCTIONS

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

Thank you for participating in this study. Your input is very important. The Clinical Information Reconciliation and Incorporation session today will last for twenty minutes. During that time you will use an instance of an electronic health record. 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 with any aspect of the tasks it likely means that something needs to be improved in the system. Please make note of it if you feel it will help us improve the usability of the system.

We will be here in case you need general questions, but we are 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 in your opinions. All of the information that you provide will be kept confidential. Your name will not be associated with any test data or comments at any time. Should you feel it necessary you are able to withdraw at any time during the testing.

Following the procedural instructions, participants were shown the EHR and as their first task, were given 10 minutes to explore the system and ask general questions. Once this task was complete, the administrator gave the following instructions:

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 instructions on Reconciling and Incorporating a patient's clinical data into their record in the EHRUT.

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 WebHIS 2.0 by measuring participant success rates and errors
2. Efficiency of WebHIS 2.0 by measuring the average task time and path deviations
3. Satisfaction with WebHIS 2.0 by measuring usability, using the System Usability Scale (SUS) overall (at the end of all the testing) and a Likert scale for ease of use for each exercise.

DATA SCORING

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

| 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. This should also be expressed as the mean number of failed tasks per participant.</p> <p>On a qualitative level, an enumeration of errors and error types should be collected.</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> |
| Efficiency: Task Time | <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> |
| Satisfaction: Task Rating | <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. 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 the [EHRUT] 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.” See full System Usability Score questionnaire in Appendix.</p> |

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. The results should be seen in light of the objectives and goals outlined in the Study Design section. The data should yield actionable results that if corrected, yield material, positive impact on user performance.

| Measure 170.315(g)3 | N | Task Success | Path Deviation | Task Time | | Errors | Task Ratings (5=Easy) |
|---|-----------|-----------------|----------------------------------|-----------------------|----------------------------------|--------------|-----------------------------|
| (b)2 | # | Mean (SD) | Deviations (Observed/Optimal) | Mean (SD) (sec) | Deviations (Observed/Optimal) | Mean (SD) | Mean (SD) |
| Reconcile and incorporate clinical information from a CCD | 10 | 100% | 1.02 | 51.1 sec | 68.1% | 0.20 | 4.40 |

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be 86%. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

MAJOR FINDINGS

- Overall the system was easy to use and will provide significant value when receiving patients from other facilities.
- There is no link to the patient's record in the WebHIS 2.0 for additional demographic and clinical verifications.
- The system is intuitive to use.
- The CCD screen displaying the various categories of clinical data should distinguish among the categories for easier viewing.
- It is easy to distinguish the clinical information that was imported from the CCD from clinical information native to the WebHIS 2.0. in the patient record.
- The link to the CCD is not labeled.

AREAS FOR IMPROVEMENT

- List the patient name in the search as a hyperlink so that the user can validate additional demographic information without leaving the screen.
- Distinguish among the various clinical categories (allergies, medications, problems, etc) on the screen to help the user target the specific data that they are looking for.
- Include a label next to the button that confirms the patient match. Currently it is simply a checkbox at the end of the row of demographic information.

- Make this same checkbox larger than it currently is.

EFFECTIVENESS

The Clinical Information Reconciliation and Incorporation program is a useful, effective application. It provides a streamlined way of accessing external records, matching them to current patients and allowing the staff to review the discrete data elements and determine whether or not they should be imported into the WebHIS 2.0.

EFFICIENCY

The efficiency of this application based on time –

The optimal time for completing this exercise was determined to be 75 seconds. The average time as demonstrated by the 10 participants was calculated to be 51 seconds. This demonstrates the usability and intuitive nature of these screens. Standard design conventions are employed in the design of all screens and applications.

Efficiency of this application based on path deviations (number of clicks) -

Based on the optimal number of 'clicks' calculated to complete this exercise, only 2 users deviated from this path, and then only by a single click, demonstrating the efficient, intuitive design of the application.

SATISFACTION

Utilizing a Likert Scale of 1-5, 5 being 'very easy' to 1 being 'very difficult', the average user rating for the Clinical Information Reconciliation and Incorporation program was -

Clinical Information Reconciliation and Incorporation - 4.40

PARTICIPANT COMMENTS

Participant comments overall reflected a high satisfaction rate with the Clinical Information Reconciliation and Incorporation application. The staff of HIM was very pleased to see such an easy intuitive application designed for them, as noted in the following quotes collected from the participants:

"I can see this being very useful, especially since I am involved with reviewing records that come in for patients who are transferred from other organizations".

"Easy and straight forward"

"The tasks were very easy and worked very well. It was very clear and easy to understand"

"This will be a positive enhancement to our current, manual workflow"