

# EHR Usability Test Report of Ankhos Clinical Oncology

## Software

*Report based on ISO/IEC 25062:2006 Common Industry Format for Usability Test Reports and NISTIR 7742*

*Customized Common Industry Format Template for Electronic Health Record Usability Testing v0.2*

Ankhos Clinical Oncology Software, v. 4.0 (Ambulatory EHR)

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## EXECUTIVE SUMMARY

A usability test of Ankhos Version 4.0 (Ambulatory EHR) was conducted between Dec 8, 2016 and December 15, 2016 in Hickory, NC and Raleigh, NC by Ankhos Oncology Software. Additional testing was performed between June 04, 2020 and June 8, 2020. The purpose of these tests was to test and validate the usability of the current user interface and provide evidence of usability in the EHR Under Test (EHRUT).

During each the usability test round, 10 healthcare providers matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks. In this case, the target demographic is comprised of nurses, physicians and support staff involved in the care of cancer patients.

This study collected performance data on 30 tasks typically conducted in an EHR:

1. CPOE - Medications – Access
2. CPOE – Medications – Record
3. CPOE – Medications - Change
4. CPOE - Labs – Access
5. CPOE – Labs – Record
6. CPOE – Labs - Change
7. CPOE - Imaging - Access
8. CPOE - Imaging - Record
9. CPOE - Imaging - Change
10. CPOE - Drug-allergy interaction
11. Demographics – Access
12. Demographics – Record
13. Demographics – Change
14. Problem List – Access,
15. Problem List – Record
16. Problem List – Change
17. Medication List – Access
18. Medication List – Record
19. Medication List – Change
20. Allergy List – Access
21. Allergy List – Record
22. Allergy List – Change
23. CDS - Allergy with weight + gender
24. CDS - Medication with weight + gender
25. CDS - Diagnosis (ICD10) with weight + gender
26. Implant. Dev. - Enter Device ID
27. Implant. Dev. - Parse and Save Device
28. Implant. Dev. - Remove device
29. CQM-Export one patient
30. CQM-Export patient list

During the 30 minute, one-on-one usability test, each participant was greeted by the administrator and asked to review and sign an informed consent/release form (included in Appendix 2); they were instructed that they could withdraw at any time. Some participants had prior experience with the EHRUT. Some participants had minimal exposure to the EHRUT. Some participants had no knowledge of the EHRUT.

The administrator introduced the test, and instructed participants to complete a series of tasks (given one at time) using the EHRUT. During the testing, the administrator timed the test and recorded user performance data on paper and electronically. The administrator did not give the 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

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. Following the conclusion of the testing, participants were asked to complete a post-test questionnaire (Appendix 4). Various recommended metrics, in accordance with the examples set forth in the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records*, were used to evaluate the usability of the EHRUT. Following is a summary of the performance and rating data collected on the EHRUT.

Task		N #	Task Success	Path Deviation	Task Time (Seconds)	Task Time (Paths)	Errors	Task Ratings (5=Easy)
			Mean % (SD)	Observed/ Optimal	Mean (SD)	Observed/ Optimal	Mean (SD)	Mean (SD)
1	CPOE - Medications – Access	10	80% (.4)	1.11 / 1	10 (5.1)	9.8 / 5	.2 (.44)	4.9 (.35)
2	CPOE – Medications – Record	10	90% (.3)	3.75 / 3	80 (65.2)	80 / 30	.2 (.44)	4.1 (1.1)
3	CPOE – Medications - Change	10	100% (0)	2.1 / 2	32.2 (23.6)	32 / 11	0 (0)	4.5 (.52)
4	CPOE - Labs – Access	10	100% (0)	2.5 / 2	14.5 (16.1)	15 / 5	.1 (.32)	4.9 (.31)
5	CPOE – Labs – Record	10	100% (0)	2.4 / 2	22.2 (16.9)	23 / 18	0 (0)	4.9 (.31)
6	CPOE – Labs - Change	10	100% (0)	2.2 / 2	14.5 (13.1)	15 / 5	0 (0)	4.9 (.31)
7	CPOE - Imaging - Access	10	100% (0)	1.3 / 1	11.3 (13.0)	11 / 5	0 (0)	5 (0)
8	CPOE - Imaging - Record	10	100% (0)	2.6 / 2	23.4 (8.7)	23 / 12	0 (0)	4.6 (.84)
9	CPOE - Imaging - Change	10	100% (0)	2 / 2	9.1 (3.2)	9 / 6	0 (0)	5 (0)
10	CPOE - Drug-allergy interaction	10	100% (0)	2.3 / 1	22.1 (11.3)	22 / 12	.3 (.48)	4.8 (.42)
11	Demographics – Access	10	90% (.3)	1 / 1	5 (2.3)	5 / 4	.2 (.44)	5 (0)
12	Demographics – Record	10	90% (.3)	2.3 / 2	15 (7.2)	15 / 7	.1 (.32)	5 (0)

13	Demographics – Change	10	90% (.3)	2.6 / 2	23.5 (20)	24 / 9	.1 (.32)	4.5 (.71)
14	Problem List – Access	10	100% (0)	1.7 / 1	18.7 (20)	19 / 5	0 (0)	4.6 (.51)
15	Problem List – Record	10	90% (.3)	4.6 / 4	30 (13.9)	30 / 12	.3 (.98)	4.3 (.71)
16	Problem List – Change	10	100% (0)	3.3 / 3	17.2 (11.8)	17 / 6	0 (0)	4.7 (.48)
17	Medication List – Access	10	90% (.3)	1.2 / 2	10.2 (12.1)	10 / 4	.1 (.32)	4.8 (.3)
18	Medication List – Record	10	100% (0)	3.7 / 3	48.4 (31.1)	48 / 16	.2 (.44)	4.6 (.51)
19	Medication List – Change	10	100% (0)	3.5 / 3	21.7 (16.4)	21 / 11	0 (0)	4.7 (.48)
20	Allergy List – Access	10	100% (0)	1.3 / 3	6.6 (4.5)	7 / 5	0 (0)	4.95 (.15)
21	Allergy List – Record	10	100% (0)	4.5 / 4	25.1 (10.2)	25 / 15	.1 (.32)	4.95 (.15)
22	Allergy List – Change	10	100% (0)	3 / 3	13.6 (6.9)	14 / 10	0 (0)	4.95 (.15)
23	CDS- - Allergy	10	100% (0)	2.4/4	20.7/10	5/3	0 (0)	4.8 (.4)
24	CDS - Medication	10	100% (0)	2.4/4	19.1/10	4/3	0 (0)	4.8(.4)
25	CDS - Diagnosis	10	100% (0)	3.1/3	25.4/10	4/3	0 (0)	4.1(.7)
26	Imp. Dev. - Enter ID	10	90% (.3)	3.8/2	70.5/25	5/2	.1 (.32)	2.4(1.11)
27	Imp. Dev. - Save	10	100% (0)	2.4/1	29.8/10	2/1	0 (0)	4.4(.8)
28	Imp. Dev. - Remove	10	100% (0)	1/1	15.1/5	5/3	0 (0)	4.9(.3)

29	CQM-Export one patient	10	100% (0)	5.3/4	31.3/20	6/3	0 (0)	4.1(.8)
30	CQM-Export patient list	10	90% (.3)	8/6	43.2/30	8/4	.1 (.32)	4.3(1.3)

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be **85.5**.

### Major Findings

1. Overall, participants could easily navigate and perform tasks in Ankhos.
2. Once tasks were completed and learned, similar tasks were easy to complete.
3. Most users had problems in the same areas (e.g. Detailed Demographics, adding an order with a pre-existing allergy).
4. Most users expected dropdowns for reaction types and medication doses.
5. Popups were largely ignored the first time by all users who encountered them.
6. Some areas need larger messaging or higher contrast to stand out (new order categories)
7. Calendar format makes accessing orders very fast.
8. Some aspects of the chart details are not as discoverable as they should be. Some items seemed to be tucked away, adding two to three unnecessary clicks (e.g. Demographics)
9. Most users were confused by the difference between the SNOMED-CT problem list and an ICD10 problem list.
10. A barcode scanner is a necessity to easily enter serial numbers for implantable devices.

### Areas for improvement

1. Make allergy interaction details clearer and provide a better way to provide feedback on what items need to be fixed to continue.
2. Consider adding dropdowns for common reaction descriptions (e.g. Hives, Shortness of



breath).

3. Consider alternative methods of conveying error statuses other than popups, such as inline text or highlighting the part of the form that needs correction.
4. Reconsider the need for additional information in some cases (e.g. dose change comment)
5. Allow users to customize more alert preferences.
6. Make Detailed demographics (language, race) more accessible from the main demographics page.
7. Consider adding descriptions to cross-map between SNOMED-CT and ICD10. While not a direct map, this may help some users understand the difference between the two code sets to more accurately code problems.
8. Make the interface for exporting patient data more prominent.

## INTRODUCTION

The EHRUT tested for this study was Ankhos v. 4.0 (Ambulatory EHR). Designed to present medical information to healthcare providers in ambulatory clinical oncology and outpatient infusion settings, the EHRUT consists of a browser-based, cloud hosted solution. 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, such time to alter a medication list or ease of modifying radiology orders, were captured during the usability testing.

## METHOD

### Participants

A total of 20 participants were tested on the EHRUT(s). Participants in the test were healthcare providers. Among them were Physicians, Nurses, Pharmacists, medical assistants and Nurse Administrators.

Participants had no direct connection to the development of or organization producing the EHRUT(s).

Participants were not from the testing or supplier organization. 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. The following is a table of participants by characteristics, including demographics, professional experience and computing experience.

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

Table 1 – Participant Demographics

ID01	Female	40-49	Bachelor's Degree	Nurse
ID02	Female	20-29	Associate Degree	MA/Phlebotomist
ID03	Female	20-29	Associate Degree	Pharm. Tech.
ID04	Female	50-59	Master's Degree	Director of Cancer Program
ID05	Female	60-69	Associate Degree	Cancer Registrar
ID06	Female	20-29	Associate Degree	MA/Phlebotomist
ID07	Male	30-39	Master's Degree	Nurse/Administrator
ID08	Female	20-29	Associate Degree	Pharm. Tech.
ID09	Female	50-59	Master's Degree	Oncology Nurse Navigator
ID10	Male	60-69	Doctorate degree (e.g. MD DNP DMD PhD)	Oncologist
ID11	Female	40-49	Associate Degree	Oncology Nurse
ID12	Female	40-49	Associate Degree	Phlebotomist
ID13	Female	40-49	Master's Degree	Physician Assistant
ID14	Female	30-39	Associate Degree	Pharmacy Nurse
ID15	Female	40-49	Master's Degree	Physician Assistant
ID16	Female	20-29	Associate Degree	MA/Phlebotomist
ID17	Female	20-29	Master's Degree	Physician Assistant
ID18	Female	60-69	Associate Degree	Nurse Manager
ID19	Male	50-59	Doctorate degree (e.g. MD DNP DMD PhD)	Oncologist
ID20	Male	60-69	Doctorate degree (e.g. MD DNP DMD PhD)	Oncologist

Ten participants (matching the demographics in the section on Participants) were recruited in the initial testing and 10 participated in the initial usability test. Subsequently, 10 different participants were recruited for a second round of testing and all 10 participated. No participant failed to show for the study. One participant was black/white colorblind and one participant was red/green colorblind.

Participants were scheduled for 30 minute sessions with 30 minutes in between each session for debrief by the administrator(s) and data logger(s), and to reset systems to proper test conditions. 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 1 EHR. Each participant used the system in similar settings, 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 table 2: Usability Metrics.

## Tasks

Tasks were constructed that would be realistic and representative of the kinds of activities a user might do with this EHR, including:

1. CPOE - Medications – Access
2. CPOE – Medications – Record
3. CPOE – Medications - Change
4. CPOE - Labs – Access
5. CPOE – Labs – Record
6. CPOE – Labs - Change
7. CPOE - Imaging - Access
8. CPOE - Imaging - Record
9. CPOE - Imaging - Change
10. CPOE - Drug-allergy interaction
11. Demographics – Access
12. Demographics – Record

13. Demographics – Change
14. Problem List – Access,
15. Problem List – Record
16. Problem List – Change
17. Medication List – Access
18. Medication List – Record
19. Medication List – Change
20. Allergy List – Access
21. Allergy List – Record
22. Allergy List – Change
23. CDS - Allergy with weight + gender
24. CDS - Medication with weight + gender
25. CDS - Diagnosis (ICD10) with weight + gender
26. Implant. Dev. - Enter Device ID
27. Implant. Dev. - Parse and Save Device
28. Implant. Dev. - Remove device
29. CQM-Export one patient
30. CQM-Export patient list

Tasks were selected based on their frequency of use, criticality of function, and those that may be most troublesome for users. Some tasks were included in the second phase to include updated features. Tasks should always be constructed in light of the study objectives.

## Procedures

Upon arrival, participants were greeted; their identity was verified and matched with a name on the participant schedule. Participants were then given a pre-assigned participant ID. Each participant reviewed and signed an informed consent and release form (See Appendix 2). A representative from the test team witnessed the participant's signature.

The test administrator was an experienced usability engineer with seven years of in-field testing and software development experience. The administrator held a Bachelor's and Master's degree in computer science with a focus on software engineering and user experience. The administrator additionally had training in producing and testing medical software and was familiar with oncology software.

The administrator moderated the session including administering instructions and tasks. The administrator also monitored task times, obtained post-task rating data, and took notes on participant comments. The Administrator served as the data logger and took notes on task success, path deviations, number and type of errors, and comments.

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

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

For each task, the participants were given a written copy of the task. Task timing began once the administrator finished reading the question. The task time was stopped once the participant indicated they had successfully completed the task. Scoring is discussed below on page 15.

Following the session, the administrator gave the participant the post-test questionnaire (e.g., the System Usability Scale, see Appendix 4), compensated them for their time, and thanked each individual for their participation. Each post-test usability questionnaire was not identified by participant in an effort to provide double-blind usability feedback.

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 tests were conducted in a quiet testing room with a table and computer for the participant. Only the participant and administrator were in the test room. 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, and visible to the participants.

## Test Environment

The EHRUT would be typically be used in a healthcare office or facility. In this instance, to accommodate the testers' schedule, the testing was conducted in private offices. For testing, the participants used the same laptop running Windows 10. The participants used a keyboard and mouse when interacting with the EHRUT.

The test Ankhos environment used a laptop with a resolution of 1920x1080.

The application was set up by the vendor according to the vendor's documentation describing the system set-up and preparation. The application itself was running on a Windows computer using a training database on a LAN connection. Technically, the system performance (i.e., response time) was representative to what actual users would experience in a field implementation. Additionally, participants were instructed not to change any of the default system settings (such as control of font size).

## Test Forms and Tools

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

1. Informed Consent
2. Incentive Receipt and Acknowledgment Form
3. Moderator's Guide
4. Post-test Questionnaire

Examples of these documents can be found in Appendices 2-5 respectively. The Moderator's Guide was devised so as to be able to capture required data.

The participant's interactions with the EHRUT was recorded by the administrator as part of the Moderator's Guide. Additionally, all verbalizations and observed reactions and path deviations were recorded by the administrator on as part of the Moderator's Guide. A video camera and microphone were not used as part of the recording procedure.

## Participant Instructions

The administrator reads the following instructions aloud to each participant (also see the full moderator's guide in Appendix 4):

*"Thank you for participating in this study. Your input is very important. Our session today will last about 30 minutes. During that time, you will use 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 all this means is that something needs to be improved in the system. I will be here in case you need specific help, but I am not able to instruct you or provide help in how to use the application.*

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

Following the procedural instructions, participants were shown the EHR and as their first task, were given time (5 minutes) to explore the system and make comments. 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 22 tasks to complete in the initial round of testing. The subsequent testing round included 8 tasks. Tasks are listed in the moderator’s guide in Appendix 4.

## 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 Ankhos by measuring participant success rates and errors
2. Efficiency of Ankhos by measuring the average task time and path deviations



### 3. Satisfaction with Ankhos by measuring ease of use ratings

#### Data Scoring

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

Table 2 - Scoring Metrics

Measures	Rationale and Scoring
<p><b>Effectiveness:</b> Task Success</p>	<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 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 20 seconds then allotted task time performance was 25 seconds. This ratio should be aggregated across tasks and reported with mean and variance scores.</p>
<p><b>Effectiveness:</b> Task Failures</p>	<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 an “Failures.” 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>
<p><b>Efficiency:</b> Task Deviations</p>	<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.</p>
	<p>It is strongly recommended that task deviations be reported. Optimal paths (i.e., procedural steps) should be recorded when constructing tasks.</p>
<p><b>Efficiency:</b> Task Time</p>	<p>Each task was timed from when the administrator said “Begin” until the participant said, “Done.” If he or she failed to say “Done,” the time was stopped when the participant stopped performing the task. Only task times for tasks that were successfully completed were included in the average task time analysis. Average time per task was calculated for each task. Variance measures (standard deviation and standard error) were also calculated.</p>

<p><b>Satisfaction:</b> Task Rating</p>	<p>Participant’s subjective impression of the ease of use of the application was measured by administering both a simple post-task question as well as a post-session questionnaire. After each task, the participant was asked to rate “Overall, this task was:” on a scale of 1 (Very Difficult) to 5 (Very Easy). These data are averaged across participants.</p> <p>Common convention is that average ratings for systems judged easy to use should be 3.3 or above.</p> <p>To measure participants’ confidence in and likeability of Ankhos 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 4.</p>
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**Table [2]. Details of how observed data were scored.**

# 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. In these test sessions, all participants were present and no data were excluded.

The usability testing results for the EHRUT are detailed below (see Table 3). The results should be seen in light of the objectives and goals outlined on page 10 Study Design. The data yielded actionable results that, if corrected, yield material, positive impact on user performance.

Table 3 - Usability Test Results

Task		N #	Task Success	Path Deviation	Task Time (Seconds)	Task Time (Paths)	Errors	Task Ratings (5=Easy)
			Mean % (SD)	Observed/ Optimal	Mean (SD)	Observed/ Optimal	Mean (SD)	Mean (SD)
1	CPOE - Medications – Access	10	80% (.4)	1.11 / 1	10 (5.1)	9.8 / 5	.2 (.44)	4.9 (.35)
2	CPOE – Medications – Record	10	90% (.3)	3.75 / 3	80 (65.2)	80 / 30	.2 (.44)	4.1 (1.1)
3	CPOE – Medications - Change	10	100% (0)	2.1 / 2	32.2 (23.6)	32 / 11	0 (0)	4.5 (.52)
4	CPOE - Labs – Access	10	100% (0)	2.5 / 2	14.5 (16.1)	15 / 5	.1 (.32)	4.9 (.31)
5	CPOE – Labs – Record	10	100% (0)	2.4 / 2	22.2 (16.9)	23 / 18	0 (0)	4.9 (.31)
6	CPOE – Labs - Change	10	100% (0)	2.2 / 2	14.5 (13.1)	15 / 5	0 (0)	4.9 (.31)
7	CPOE - Imaging - Access	10	100% (0)	1.3 / 1	11.3 (13.0)	11 / 5	0 (0)	5 (0)
8	CPOE - Imaging - Record	10	100% (0)	2.6 / 2	23.4 (8.7)	23 / 12	0 (0)	4.6 (.84)
9	CPOE - Imaging - Change	10	100% (0)	2 / 2	9.1 (3.2)	9 / 6	0 (0)	5 (0)
10	CPOE - Drug-allergy interaction	10	100% (0)	2.3 / 1	22.1 (11.3)	22 / 12	.3 (.48)	4.8 (.42)
11	Demographics – Access	10	90% (.3)	1 / 1	5 (2.3)	5 / 4	.2 (.44)	5 (0)
12	Demographics – Record	10	90% (.3)	2.3 / 2	15 (7.2)	15 / 7	.1 (.32)	5 (0)

13	Demographics – Change	10	90% (.3)	2.6 / 2	23.5 (20)	24 / 9	.1 (.32)	4.5 (.71)
14	Problem List – Access	10	100% (0)	1.7 / 1	18.7 (20)	19 / 5	0 (0)	4.6 (.51)
15	Problem List – Record	10	90% (.3)	4.6 / 4	30 (13.9)	30 / 12	.3 (.98)	4.3 (.71)
16	Problem List – Change	10	100% (0)	3.3 / 3	17.2 (11.8)	17 / 6	0 (0)	4.7 (.48)
17	Medication List – Access	10	90% (.3)	1.2 / 2	10.2 (12.1)	10 / 4	.1 (.32)	4.8 (.3)
18	Medication List – Record	10	100% (0)	3.7 / 3	48.4 (31.1)	48 / 16	.2 (.44)	4.6 (.51)
19	Medication List – Change	10	100% (0)	3.5 / 3	21.7 (16.4)	21 / 11	0 (0)	4.7 (.48)
20	Allergy List – Access	10	100% (0)	1.3 / 3	6.6 (4.5)	7 / 5	0 (0)	4.95 (.15)
21	Allergy List – Record	10	100% (0)	4.5 / 4	25.1 (10.2)	25 / 15	.1 (.32)	4.95 (.15)
22	Allergy List – Change	10	100% (0)	3 / 3	13.6 (6.9)	14 / 10	0 (0)	4.95 (.15)
23	CDS- - Allergy	10	100% (0)	2.4/4	20.7/10	5/3	0 (0)	4.8 (.4)
24	CDS - Medication	10	100% (0)	2.4/4	19.1/10	4/3	0 (0)	4.8(.4)
25	CDS - Diagnosis	10	100% (0)	3.1/3	25.4/10	4/3	0 (0)	4.1(.7)
26	Imp. Dev. - Enter ID	10	90% (.3)	3.8/2	70.5/25	5/2	.1 (.32)	2.4(1.11)
27	Imp. Dev. - Save	10	100% (0)	2.4/1	29.8/10	2/1	0 (0)	4.4(.8)
28	Imp. Dev. - Remove	10	100% (0)	1/1	15.1/5	5/3	0 (0)	4.9(.3)

29	CQM-Export one patient	10	100% (0)	5.3/4	31.3/20	6/3	0 (0)	4.1(.8)
30	CQM-Export patient list	10	90% (.3)	8/6	43.2/30	8/4	.1 (.32)	4.3(1.3)

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be: **85.5**. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

## Discussion of the Findings

### EFFECTIVENESS

1. The most common source of errors and deviations was the allergy notification alert. In task 1 and task 18, an allergy must be overridden. Nearly all participants failed to read the popup requesting an override comment.
  - a. "Allergy warning should be more visible."
2. Another common deviation was not noticing that orders can be created by typing in the orderable search box. In some cases, this led to searching for another method to order.
3. The third most common deviation was encountered when a warning was issued for a dose change that required a comment.

Participant Comments:

  - a. "Why do I need a comment to change dose?"
4. The fourth common source of deviations was a confusion between medication order and an entry in the medication list.
5. Another common frustration was the effort involved in typing in a device identifier.

"I wouldn't use this unless I had a barcode scanner" was commented 3 times.
6. Most other deviations seemed to be a result of learning the system. For instance, *Task 2 - Create Medication Order* the average participant path was 3.7 steps while *Task 5 – Create Laboratory Order* had an average participant path of 2.2 steps, indicating that there was more certainty about how to create orders as the participant progressed through the tasks.
  - a. "This is easy to use once I know how"
  - b. "It's easy to make orders."
  - c. "It would be nice to have a dropdown for dose."
  - d. "This is very much like what I do at work now, but easier"
7. A similar learning effect is found between tasks for allergies and medications, where the optimal paths are very similar. *Task 19 – Medication List – Change* had an average path length of 3.5 (.97) while *Task 22 - Allergy List – Change –* had an average path length of 3.0 (0)
  - a. "I was expecting a dropdown for hives"

### EFFICIENCY

1. Task times for accessing records (Tasks 1,4,7,11,14,17,20) were relatively small (5-10 seconds) and the variation between participants was low (2.3-16 second SD)



2. Task time was independent of computer experience and age. Some older users accomplished tasks more efficiently than younger “digital-native” users.
3. Education and professional role had little statistical effect on task efficiency.
4. Tasks with the highest average completion times were also rated with the lowest usability scores.

## SATISFACTION

### *Subjective*

#### Positive Comments

“This is easy to use once I know how”.

“I’m not good at computers, but I like this system because I can peck around and find things... very easy to figure out.”

“It’s easy to make orders”

“This is very much like what I do at work now, but easier.”

“I am colorblind and this is still easy to use.”

#### Negative Comments

“I think a problem should be active by default.” (Problem List)

“I was expecting a dropdown for hives” (Allergy type, medication route)

“The button to save is not obvious” (Demographics)

“I can’t find language and ethnicity” (Demographics)

“Requires too many clicks” (Demographics)

“Allergy warning should be more visible”

“Order dropdowns are hard to find”

“I didn’t know I could type in orderable box”

“I wouldn’t use this without a barcode scanner”

“The Decision support site could look better”

### *Objective*

The average usability rating of all completed tasks was 4.1 (5=very easy).

As in appendix 4, each participant anonymously filled out the Likert usability score to judge overall system usability. The *System Usability Score* was 85.5 with a maximum of 100.

## MAJOR FINDINGS

11. Overall, participants could easily navigate and perform tasks in Ankhos.
12. Once tasks were completed and learned, similar tasks were easy to complete.
13. Most users had problems in the same areas (e.g. Detailed Demographics, adding an order with a pre-existing allergy).
14. Most users expected dropdowns for reaction types and medication doses.
15. Popups were largely ignored the first time by all users who encountered them.
16. Some areas need larger messaging or higher contrast to stand out (new order categories)
17. Calendar format makes accessing orders very fast.
18. Some aspects of the chart details are not as discoverable as they should be. Some items seemed to be tucked away, adding two to three unnecessary clicks (e.g. Demographics)
19. Most users were confused by the difference between the SNOMED-CT problem list and an ICD10 problem list.

## AREAS FOR IMPROVEMENT

9. Make allergy interaction details clearer and provide a better way to provide feedback on what items need to be fixed to continue.
10. Consider adding dropdowns for common reaction descriptions (e.g. Hives, Shortness of breath).
11. Consider alternative methods of conveying error statuses other than popups, such as inline text or highlighting the part of the form that needs correction.
12. Reconsider the need for additional information in some cases (e.g. dose change comment)
13. Allow users to customize alert preferences.
14. Make Detailed demographics (language, race) more accessible from the main demographics page.
15. Consider adding descriptions to cross-map between SNOMED-CT and ICD10. While not a direct map, this may help some users understand the difference between the two code sets to more accurately code problems.
16. Make the patient export easier to find.

## APPENDICES

### Appendix 1: Participant Demographics

Following is a high-level overview of the participants in this study.

#### Gender

Men	4
Women	16
Total	20

#### Occupation/Role

Physician	3
RN/BSN/OCN (Oncology Certified Nurse)	6
Nurse Cancer Navigator	1
Medical Assistant/Technician	3
CPhT (Pharmacy Technician)	3
Cancer Registrar	1
Physician Assistant / Nurse Practitioner	3
Total	20

#### Years of Experience with EHRT

Total professional experience (total years)	309
Years Experience with EHRUT (total years)	8
All Paper (total years)	150
Some Paper, Some Electronic (total years)	50
All Electronic (total years)	75
Total (Total participants)	20



## Appendix 2: Informed consent form

### **Informed Consent**

Ankhos Oncology software would like to thank you for participating in this study. The purpose of this study is to evaluate an electronic health records system. If you decide to participate, you will be asked to perform several tasks using the prototype and give your feedback. The study will last about 30 minutes. At the conclusion of the test, you will be compensated for your time.

#### *Agreement*

I understand and agree that as a voluntary participant in the present study conducted by Ankhos Oncology Software. I am free to withdraw consent or discontinue participation at any time. I understand and agree to participate in the study conducted Ankhos Oncology Software.

I understand and agree that the purpose of this study is to make software applications more useful and usable in the future.

I understand and agree that the data collected from this study may be shared with outside of Ankhos Oncology Software. I understand and agree that data confidentiality is assured, because only de- identified data – i.e., identification numbers not names – will be used in analysis and reporting of the results.

I agree to immediately raise any concerns or areas of discomfort with the study administrator. I understand that I can leave at any time.

#### **Please check one of the following:**

- YES, I have read the above statement and agree to be a participant.
- NO, I choose not to participate in this study.

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

## Appendix 3: Moderator Test Script

Begins on next page

## EHRUT Usability Test

### Moderator's guide

Administrator: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

Participant #: \_\_\_\_\_

Location: \_\_\_\_\_

### Prior to testing:

Confirm schedule with participants \_\_ Done

Ensure EHRUT lab environment is running properly \_\_Done

### Prior to each participant:

Reset Application

Begin study record

### Prior to each task

Reset application to starting point for next task

### After each participant

Finalize Study record

### After all testing

Backup all study records

### Orientation (5 minutes)

Thank you for participating in this study. Our session today will last 30 minutes. During that time, you will look at an electronic health record system.

I will ask you to complete a few tasks using this system and answer some questions. 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. You will be asked to complete these tasks on your own trying to do them as quickly as possible with the fewest possible errors or deviations. Do not do anything more than asked. If you get lost or have difficulty I cannot answer help you with anything to do with the system itself. Please save your detailed comments until the end of a task or the end of the session as a whole when we can discuss freely.

Please be honest with your opinions.

The product you will be using today is a demo version of Ankhos, populated with sample data. Some of the data may not make sense as it is placeholder data.

All of the information that you provide will be kept confidential and your name will not be associated with your comments at any time.

Do you have any questions or concerns?

### Preliminary Questions (1 minute)

What is your job title / appointment?

How long have you been working in this role? What are some of your main responsibilities?

Tell me about your experience with electronic health records.



### First Impressions (30 Seconds)

“This is the application you will be working with. Have you heard of it?” \_\_Yes \_\_No

“If so, tell me what you know about it.”

Show test participant the EHRUT.

“Please don’t click on anything just yet. What do you notice? What are you able to do here? Please be specific.”

Notes/comments

### 1. CPOE - Medications – Access

Access Medication orders on patient calendar.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 2. CPOE – Medications – Record

Create a medication order for “Decadron 10 mg IV Push”

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 3. CPOE – Medications – Change

Change the dose of the previous order (Decadron) to 5 mg.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

#### 4. CPOE - Labs – Access

Access Lab orders on patient calendar.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

#### 5. CPOE – Labs – Record

Create a lab order for “Magnesium (Level)”

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

#### 6. CPOE – Labs – Change

Mark the previous lab order as void

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 7. CPOE - Imaging – Access

Access imaging orders on patient calendar.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 8. CPOE - Imaging – Record

Create an imaging order for “CT-Chest - Contrasted”

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 9. CPOE - Imaging – Change

After creating the imaging order, set the status to void

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

#### 10. CPOE - Drug-allergy interaction

The patient has an allergy to Decadron. Attempt to order Decadron and observe the alerts and/or restrictions.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

#### 11. Demographics – Access

Access Patient demographics

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

#### 12. Demographics – Record

Set the gender of the patient to Male

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 13. Demographics – Change

Set the patient preferred language to Spanish

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 14. Problem List – Access

Access SNOMED problem list

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 15. Problem List – Record

Search for Atrial Fibrillation and add it to the patient's problem list

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 16. Problem List – Change

Set the status of the new problem to Void

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 17. Medication List – Access

Access the patient's Medication List

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 18. Medication List – Record

Record a new medication entry for Dexamethasone 0.5 MG Oral Tablet with instructions "Take 1 prior to treatment appointments"

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 19. Medication List – Change

Change the instructions for the previous medication entry to “Take 1 daily”

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 20. Allergy List – Access

Access the patient’s allergy list.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

### 21. Allergy List – Record

Record a new allergy for the drug class “Sulfonamides” with a reaction of “hives”.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations



## 22. Allergy List – Change

Modify the previous allergy entry to have a description of “rash”.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

Task Time: \_\_\_\_ Seconds

Observed Errors and Verbalizations

## 23. CDS - Allergy with weight + gender

Request CDS information regarding a patient’s allergy and gender from the patient allergy list

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

## 24. CDS - Medication with weight + gender

Request CDS information regarding a patient’s medication and gender from the patient medication list

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

### 25. CDS - Diagnosis (ICD10) with weight + gender

Request CDS information regarding a patient's medication and gender from the patient ICD10 diagnosis list

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

### 26. Implant. Dev. - Enter Device ID

Enter a device identifier in the patient's chart under Implantable devices.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

### 27. Implant. Dev. - Parse and Save Device

Select the "parse" button to parse and save the device identifier

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

### 28. Implant. Dev. - Remove device

Remove/archive the device identifier from the chart

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

### 29. CQM-Export one patient

Using the Downloads/Export CQM/MIPS tab, select a date range and CQM measure for which to download results. Export one patient report.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

### 30. CQM-Export patient list

Using the Downloads/Export CQM/MIPS tab, select a date range and CQM measure for which to download results. Export the patient list.

Easily Completed  With Difficulty  Not Completed

Correct  Minor Deviations  Major Deviations

Rating from Very Easy (5) to Very Difficult (1): \_\_\_\_

## Appendix 4: System Usability Scale Questionnaire

In 1996, Brooke published a “low-cost usability scale that can be used for global assessments of systems usability” known as the System Usability Scale or SUS.<sup>16</sup> Lewis and Sauro (2009) and others have

elaborated on the SUS over the years. Computation of the SUS score can be found in Brooke’s paper, in at <http://www.usabilitynet.org/trump/documents/Suschapt.doc> or in Tullis and Albert (2008).

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
2. I found the system unnecessarily complex	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
3. I thought the system was easy to use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
5. I found the various functions in this system were well integrated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
6. I thought there was too much inconsistency in this system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
8. I found the system very cumbersome to use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
9. I felt very confident using the system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1	2	3	4	5

