EHR USABILITY TEST REPORT
OF ACUMEN NEHR® V.7.4

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

Date of Usability Test: August 9, 2017

Date of Report: October 5, 2017

Report Prepared by: Department of User Experience, Fresenius Medical Care NA

Mary Vasseur Finn, CUA, Sr. UX Designer, Fresenius Medical Care NA

781.676.5423

mary.finn@fmc-na.com

32 Hartwell Ave., Lexington, MA 02421

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A usability test of Acumen nEHR® v.7.4 was conducted on August 9, 2017 in Nashville, Tennessee by members of the User Experience Department of Fresenius Medical Care NA. 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, 13 healthcare providers and clinic staff matching the target demographic criteria served as participants and used the EHRUT in simulated, but representative tasks.

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

- Locating and editing a patient's demographic information

- Documenting a patient's having an implantable device in a patient's chart

- Reconciling new medication prescriptions coming from other clinicians

- Changing and updating diagnoses in a patient's chart

- Documenting the fulfillment of CQM requirements

- Ordering laboratory tests

- Ordering diagnostic imaging tests

During the 60-minute one-on-one usability test, each participant was greeted by an administrator and asked to review and sign an informed consent/release form (see APPENDIX 1); they were instructed that they could withdraw at any time. All participants had some prior experience with the EHR. The administrator introduced the test, and instructed participants to complete a series of tasks (given one at a time) using the EHRUT. During the testing, the administrator timed the test and recorded user performance data on paper. The administrator did not give the participant assistance in how to complete the task. Participant screens, head shots and audio were recorded for subsequent analysis and referral.

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 and were compensated for their time with a backup charger for electronic devices, a Starbucks gift card, and an entry into a raffle to win an iPad Mini. 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:

Measure Task	N #	Task Success Mean (SD)	Path Deviation Deviations (Observed / Optimal)	Task Time Mean (SD)	 Deviations (Observed / Optimal)	Errors Mean (SD)	Task Ratings 1=Easy Mean (SD)
1. Locating and editing a patient's demographic information (170.315(a)(5) Demographics)	12	0.83 (1.29)	1.80	60 (153)	1.28	3.96 (2.02)	1.65 (0.19)
2. Documenting a patient's having an implantable device in their chart 170.315(a)(14) Implantable device list)	12	0.83 (1.29)	1.23	116 (53)	2.58	3.06 (5.76)	1.08 (0.59)

3. Reconciling new medication prescriptions coming from other clinicians (170.315(b)(2) Clinical information reconciliation and incorporation)	12	0.33 (1.63)	1.91	119 (126)	1.13	9.52 (7.60)	2.62 (1.14)
4. Changing and updating diagnoses in a patient's chart (170.315(a)(6) Problem list)	12	0.75 (1.5)	1.30	67 (58)	1.52	3.37 (5.40)	1.35 (0.69)
5. Documenting the fulfillment of CQM requirements (170.315(a)(9) Clinical decision support)	12	.50 (1.73)	1.00	47 (121)	1.27	4.02 (5.07)	1.77 (1.22)
6. Ordering laboratory tests (170.315(a)(2) CPOE– laboratory)	12	.25 (1.5)	1.50	110 (76)	1.47	6.16 (11.53)	1.88 (0.94)
7. Ordering diagnostic imaging tests (170.315(a)(3) CPOE – diagnostic imaging)	12	.08 (1.0)	1.62	89 (93)	2.23	7.57 (13.37)	2.00 (1.02)

Table 1: Performance and Rating Data Summary

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be 75.6.

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

MAJOR FINDINGS

Since users were all familiar with the application, usability issues surfaced only where users were asked to perform tasks not familiar to them. These manifestations were in the form of participants' higher than optimal time on tasks, clicks, and quit rates. The major issues that came to the fore fell in the areas of: Learnability, iconography, architecture, and overall visual design, and were most notable in Tasks 3, 5 and 6 (CPOE–CR, and CPOE Lab/Image Ordering).

AREAS FOR IMPROVEMENT

A cleaner, more orderly and simple visual design would significantly upgrade the application's usability in terms of effectiveness, efficiency and satisfaction. This whould include new, clean icons; consistent text sizes and weights (through which use the architecture will also be more apparent); limited and intelligent use of color; and strategic placement of frequently used interactive elements.

INTRODUCTION

The EHRUT tested for this study was Acumen nEHR® v.7.4. Designed to present medical information to healthcare providers in nephrologists' offices and clinics, the application securely manages, distributes and stores patient health record, both within the Acumen system and among the practices' care team. 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 as time on task, success rates and number of clicks were captured during the usability testing.

METHOD

PARTICIPANTS

A total of 13 participants were tested on the EHRUT. Participants in the test were actual users of the EHRUT, working in the field of nephrology. These included but were not limited to: Nurses, medical assistants, billing specialists and office managers. Participants were recruited by Acumen and were compensated for their time with small gifts and entry into a raffle. None of the participants had direct connection to the development of or organization producing the EHRUT. Participants were not from the testing or supplier organization, but drawn from the current user population — willing registrants attending an annual user conference.

The following table, TABLE 1, 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 could not be tied back to individual identities.

	Part ID	Gender	Age	Education	Occupation/ Role	Professional Experience (Months)	Computer Experience (Months)	Product Experience (Months)	Assistive Technology Needs
1	MP01	F	40-49	Some college	Insurance/ Billing clerk	240+	180-239	48	No
2	JP02	F	40-49	High School graduate	CMA/Front desk	180-239	120-179	60	No
3	KP03	F	50-59	Bachelor's Degree	Manager	240+	240+	72	No
4	JP05	F	40-49	Master's Degree	Executive Director	240+	240+	84	No
5	KP06	F	30-39	Master's Degree	Director of Operations	180-239	240+	48	No
6	MP07	M	30-39	Master's Degree	Practice Administrator	180-239	240+	3	No
7	JP08	F	20-29	High School graduate	Team Lead	0-59	60-119	72	No
8	KP09	F	40-49	Bachelor's Degree	Practice Manager	180-239	180-239	72	No
9	MP10	F	30-39	Some college	Team Lead/MA	120-179	120-179	72	No
10	JP11	F	30-39	Bachelor's Degree	Patient Accounts	120-179	120-179	48	No
11	KP12	F	40-49	Some college	Office Manager	180-239	120-179	84	No
12	MP13	F	40-49	Bachelor's Degree	Clinical Operations Director	240+	240+	12	No
13	KP15	M	40-49	Some college	IT Manager	240+	240+	72	No

Table 2: Participant Demographics

Fifteen participants were initially recruited and 13 participated in the usability test. Four participants failed to

show for the study, and two were recruited on-site.

Participants were scheduled for 60-minute sessions with 15 minutes in between each session for debrief by

the administrators, and to reset systems to proper test conditions. A spreadsheet was used to keep track of the participant schedule.

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 will serve 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 3.9 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:

1. Locating and editing a patient's demographic information (170.315(a)(5) Demographics)

2. Documenting a patient's having an implantable device in their chart 170.315(a)(14) Implantable device list)

3. Reconciling new medication prescriptions coming from other clinicians (170.315(b)(2) Clinical information reconciliation and incorporation)

4. Changing and updating diagnoses in a patient's chart (170.315(a)(6) Problem list)

5. Documenting the fulfillment of CQM requirements (170.315(a)(9) Clinical decision support)

6. Ordering laboratory tests (170.315(a)(2) CPOE– laboratory)

7. Ordering diagnostic imaging tests (170.315(a)(3) CPOE – diagnostic imaging)

Tasks were selected based on their frequency of use, criticality of function, and those that were new and unfamiliar to users.

PROCEDURES

Upon arrival, participants were greeted; their identity was verified and matched with a name and Participant ID on the participant schedule. Fresh "recruits" were added to the schedule as needed and assigned a Participant ID.

Each participant reviewed and signed two duplicate informed consent and release forms (see APPENDIX 1). The administrator witnessed the participant's signature, and gave one of the two copies to the participant.

The three usability testing administrators conducting the test were experienced usability practitioners with a combined 14 years experience, two with Bachelors degrees and UX Certificates, and one with a Masters degree in Human Factors Information Design.

The administrators moderated the session including administering instructions and tasks. The administrators also monitored task times, obtained post-task rating data, and took notes on path deviations, number and type of errors, and comments.

Participants were instructed to perform the tasks:

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

- Without assistance; administrators were allowed to give immaterial guidance and clarification on tasks, but not instructions on how to complete them

- Using a minimal 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 in Section 3.9.

Participants' demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire were documented on paper and later compiled and transferred to a spreadsheet.

Following the session, the administrator gave the participant a post-test questionnaire, the System Usability Scale, see APPENDIX 2), thanked them for their time and willingness to participate, and gave them small compensatory gifts for their time, as well as a contact card should they have any questions for the administrator afterwards.

TEST LOCATION

The testing, integrated into the schedule of Acumen's annual users' conference, took place in a private function room at the Hilton Nashville Downtown Hotel in Nashville, Tennessee.

A waiting area was set up outside the room. Only participants and administrators were permitted in the test room. To ensure that the environment was comfortable for users, noise levels were kept to a minimum, and the ambient temperature kept 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, the testing was conducted in a hotel function room. The room, 21 X 35 feet, was divided by partitions to enable three sessions to be conducted concomitantly. For testing, the computers used were MacBook Pros running OS Sierra 10.12.6. The participants used external mice and the laptops' keyboards when interacting with the EHRUT.

The MacBook Pros used had 2015 model 15-inch screens (2) and a 2016 model 15-inch Retina display (1). The application, being web-based, precluded the need for installation, and was accessed via Google Chrome Version 60.0.3112.101. The application database was prepopulated with simulated data prior to the test date. Technically, the system performance (i.e., response time) was representative to what actual users would experience in a field implementation. Participants were not permitted to change any of the default system settings.

TEST FORMS AND TOOLS

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

1. Moderator Guide (APPENDIX 2)

2. Informed Consent (APPENDIX 3)

3. Tasks' script and post-task surveys (APPENDIX 4)

4. Normative survey (APPENDIX 5)

5. Introductory verbal introduction and instructions script (APPENDIX 6)

6. System Usability Scale (SUS) (APPENDIX 7)

7. Subjective Satisfaction Survey (APPENDIX 8)

8. Debriefing Statement (APPENDIX 9)

The participant's interaction with the EHRUT was captured and recorded digitally with screen capture software running on the test machine (Silverback Version 3.1.5). The laptop's camera recorded each participant's facial expressions synced with the screen capture and mouse clicks; the laptop's internal microphone recorded verbal comments.

PARTICIPANT INSTRUCTIONS

The administrator read the following instructions aloud to each participant:

"*Thank you for taking the time to participate in this study. As mentioned in the Informed Consent document that you just signed, you will be performing a number of tasks on the computer. The one request that we would have is that you think out loud. As you are looking around the screen describe what you think, articulate how you are feeling during each task, and express any thoughts or decisions you are making during each task, as well as any points of confusion that you encounter.*

We would like you to do these tasks on your own, so we may not actually be able to give you any assistance; however, you are free to use the User Guide at any time. Also, keep in mind that it is all right to fail at a task. If you do, please know that this is a failure of the design and should not be taken as a fault of your own. These errors and points of confusion are actually what we are here to find."

Do you have any questions before we begin?" [Pause, and answer any questions]

Great! If there is nothing else, let's begin."

Welcome to the user study of the various features of Acumen v7.4."

During the next hour you will be given 21 simple tasks to perform. After each task, you will be asked a few simple questions about the task. You may be asked to perform tasks that are outside of your normal profession. If this is the case, please do your best to complete the task as if it was actually part of your current job role."

If you get stuck, you may give up, or, I may ask you to abandon a task and proceed to the next one. In some cases where a task builds on the success of another, I may step in to provide assistance."

Thank you for your decision to participate!"

Participants were then given, one at a time, and in randomized order, seven sets of tasks to complete. (Broken down, there are a total of 21 "subtasks." See APPENDIX 3 for actual task scripts.)

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 the EHRUT by measuring participant success rates and errors

2. Efficiency of the EHRUT by measuring the average task time and number of clicks

3. Satisfaction with the EHRUT by measuring ease of use ratings

DATA SCORING

The following table (TABLE 3) details how tasks were scored, errors evaluated, and time data analyzed.

Measure	Rationale and Scoring
Effectiveness	
Task Success	A task was counted as a "Success" if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis.

	The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage. Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency.
Task Failure	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.
Efficiency	
Task Deviation	The participant's path 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.
Task Time	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.
Satisfaction	
Task Rating	Participant's subjective impression of the ease of use of the application was measured by administering both a simple post-task question as well as a post-session questionnaire. After each task, the participant was asked to rate "Overall, this task was:" on a scale of 1 (Very Easy) to 5 (Very Difficult). These data are averaged across participants. Common convention is that average ratings for systems judged easy to use should be 3.3 or above. To measure participants' confidence in and likeability of the [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 APPENDIX 7: SYSTEM USABILITY SCALE)v

Table 3: Scoring, Evaluation and Analysis

RESULTS

Data Analysis and Reporting

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

section above. Data from all thirteen participants were used in the analysis, except for the efficiency

measures of one participant, whose screen and clicks' data was lost because of technical problems. The

usability testing results for the EHRUT are detailed below (see TABLE 4):

Measure Task	N #	Task Success Mean (SD)	Path Deviation Deviations (Observed/ Optimal)	Task Time Mean (SD)	Deviations (Observed/ Optimal)	Errors Mean (SD)	Task Ratings 1=Easy Mean (SD)
1. Locating and editing a patient's demographic information	12	0.83 (1.29)	1.80	60 (153)	1.28	3.96 (2.02)	1.65 (0.19)
2. Documenting a patient's having an implantable device in their chart	2	0.83 (1.29)	1.23	116 (53)	2.58	3.06 (5.76)	1.08 (0.59)
3. Attaching documents from outside sources to a patient's chart	12	0.33 (1.63)	1.91	119 (126)	1.13	9.52 (7.60)	2.62 (1.14)
4. Reconciling new medication prescriptions coming from other clinicians	12	0.75 (1.5)	1.30	67 (58)	1.52	3.37 (5.40)	1.35 (0.69)
5. Changing and updating diagnoses in a patient's chart	12	.50 (1.73)	1.00	47 (121)	1.27	4.02 (5.07)	1.77 (1.22)
6. Documenting the fulfillment of CQM requirements	12	.25 (1.5)	1.50	110 (76)	1.47	6.16 (11.53)	1.88 (0.94)
7. Ordering labs and radiologic diagnostics	12	.08 (1.0)	1.62	89 (93)	2.23	7.57 (13.37)	2.00 (1.02)

Table 4: Performance and Rating Data Summary

Effectiveness

Measuring effectiveness by degree of success took into account the following criteria: Whether or not a

participant needed assistance in order to successfully complete a task; whether they erroneously believed to have been successful; when they were asked by the moderator to abandon a task and move on, and when they chose to quit. In the cases where a moderators asked a participant to move on, the termination time was set at five minutes after task start, five minutes being deemed well in excess of what would normally be considered a reasonable amount of time for these tasks. Only tasks successfully completed within 5:00 minutes without assistance were considered successes. Results show that Task 5 has moderate usability problems; Task 3 has serious usability problems; and Tasks 6 and 7 have critical usability problems.

Efficiency

Efficiency was measured as a function of time on task relative to pre-determined benchmark (optimal) task times, and clicks per task relative to benchmark task values.

Satisfaction

Satisfaction was measured by taking into account results from post-task Impression of Ease surveys, System Usability Scale scores (SUS), and a Subjective Satisfaction Surveys to supplement the quantitative data.

Ease of Use

Perceived ease of use ratings were gauged on a 5-point Likert scale. Ease of use was rated per task set, e.g., Task 1 (1 = 1-1, 1-2 and 1-3 together).

Usability

Usability was rated against the application as a whole. The overall application was rated by participants with a SUS score of 75.6; with usability specifically at 76.9, and learnability at 70.2. Following is a breakdown of the average rating for each criterion:

System Usability Scale (SUS) Criterion	Average score
I think that I like to use this system frequently	86.5
I find the system unnecessarily complex	75.0
I think the system is easy to use	86.5
I think that I need the support of a technical person to be able to use this system	71.2
I find the various functions in this system are well integrated	75.0
I think there is too much inconsistency in this system	67.3
I would imagine that most people would learn to use this system very quickly	69.2
I find the system very cumbersome to use	71.2
I feel very confident using the system	84.6
I needed to learn a lot of things before I could bet going with this system	69.2

Discussion of the Findings

Effectiveness

Problems with effectiveness were most evident in Tasks 3, 6 and 7, where quit rates and/or false success rates were highest relative to the other tasks.

Task 3-3 (Transitions of Care and Clinical Reconciliation). From your patient's chart, select the inbound CCD sent by Baptist Hospital in order to reconcile the information. Accept the new medication of Norvasc 5mg from the Baptist Hospital list and reconcile.

For this task, participants had difficulty even finding the Inbound CCD. For those who did find it, many did not "get" the REC link (Reconcile) juxtaposed to the inbound document in the list. For these reasons alone people quit or were terminated. If they made it as far as opening the document to be reconciled, the lack of clear order on the Reconcile screen caused some to give up prematurely, not easily understanding what was being presented on the screen. The checkboxes "Keep" and "Do not Reconcile" were confusing because they ought to have been a proximal pair, styled identically. The Reconcile button at the bottom of the screen adds to the confusion.

Tasks 6-1, 6-3 (CPOE Laboratory). Dr. Smith has requested that your patient have an

ultrasound done today. Indicate Dr. Smith is the ordering provider and the test is to be done routine.

Task 7-3 (CPOE Diagnostic Imaging). Complete the task and the order for the ultrasound.

For these three tasks, users across the board had trouble finding the order form in the dropdown — an odd thing, as one would expect to land on that screen first off. Not seeing the Routine and Stat radio buttons, many entered Stat or Routine in the Special Instructions text field. Not know if what they were doing was right or not caused users to second-guess themselves, doing and undoing various actions on the screen. More seriously, most thought that clicking the "Sign and Close" button completed the task, a reasonable assumption, one would think, one of the dictionary definitions of *close* being, "bring or come to an end." All of this led to a large portion of the participants failing the task, or thinking they had succeeded when they hadn't.

Efficiency

Problems with efficiency were most evident in Tasks sets 5 (CDS Workflow), 6 (CPOE Laboratory), and 7 (CPOE Diagnostic Imaging), where time on task rates were highest relative to their counterpart benchmark times.

5 – (CDS Workflow). For this task, finding the CQM alert on the patient's chart began the difficulty; when they found it and accessed the screen, the excessive amount of text, unaligned and in various font sizes and weights, impeded their speed. The odd background colors intended to differentiate what needed attention from what didn't, perplexed users new to this task, adding to the delay in completing it.

6 – (CPOE Laboratory) and 7 – (CPOE Diagnostic Imaging). See above, under effectiveness. The same problems that made participants fail, made them likewise inefficient.

Satisfaction

SUS

The overall application was rated by participants with a SUS score of 75.6; with usability specifically at 76.9,

and learnability at 70.2. (In the world of industry in general, the average System Usability Scale score is 68, which means your site or application is passable but needing improvement in terms of usability. 80.3 or higher is reckoned equivalent to an "A." 51 or under is more or less reckoned equivalent to an "F.")

Impression of Ease survey

While the mean rating for ease of use given by participants equaled 2.03 ("Easy" on a 5-point scale where 1=Very easy and 5=Very difficult), their performance on those same tasks belies that rating. Users consistently rated tasks as easy, even when they had false successes.

Subjective satisfaction survey

Participants had little negative to say about the EHRUT. It may be noted, however, that many who praised the application, did so from the vantage point of using or having used other eHRs — which they deemed much less usable and enjoyable than Acumen's eHR.

Major Findings

Since users were all familiar with the application, usability issues surfaced only where users were asked to perform tasks not familiar to them. These manifestations were in the form of participants' higher than optimal time on tasks, clicks, and quit rates. The major issues that came to the fore fell in the areas of: Learnability, iconography, architecture, and overall visual design, and were most notable in Tasks 3, 5 and 6 (CPOE–CR, and CPOE Lab/Image Ordering).

Learnability. While all of the participants spoke positively about their experience with the EHRUT, a fair number expressed that is difficult to learn: "Once learned, it's easy to use … after the learning curve. [It's in the] Learning [process] where everything is difficult." This was supported in the SUS findings, where the learnability score was 70.2 — basically equivalent to a "C" grade.

Iconography. Users frequently found themselves in trouble when they were unable to recognize the meaning of icons which, besides failing to conform to common conventions seen in other applications, were sometimes used to represent one thing in one screen, and another thing in another screen.

Architecture. Users praised the application's having comprehensive patient information on one screen, however, the sometimes confusing paths that need to be followed to achieve certain goals posed difficulties for many. The application is clearly not mapped to specific tasks, or tailored for different user-groups; this caused users to struggle with circuitous paths when performing, or attempting to perform, certain tasks.

Visual Design. The cluttered and disordered and visual elements added to the cognitive load, making new tasks take significantly longer than necessary, and exacerbating the challenges with navigating through screens looking for the proper path to perform a task.

Areas for improvement

While it must be stated that a redesign of the application's entire architecture is in order, many issues could be remedied or improved without a great deal of investment. A quick comb-through of the application to identify inconsistent and/or inappropriate use of icons, and replace them, would make fair improvements to its usability in terms of effectiveness.

More than anything else, a cleaner, more orderly and simple visual design would significantly upgrade its usability in terms of effectiveness, efficiency and satisfaction. This should include new, clean icons; consistent text sizes and weights (through which use the architecture will also be more apparent); limited and intelligent use of color; and strategic placement of frequently used interactive elements and critical information.

APPENDICES

Appendix 1: Participant demographics

Appendix 2: Moderator Guide

Appendix 3: Informed Consent

Appendix 4: Tasks' script and post-task surveys

Appendix 5: Normative survey

Appendix 6: Introductory verbal introduction and instructions script

Appendix 7: System Usability Scale (SUS)

Appendix 8: Subjective Satisfaction Survey

Appendix 9: Debriefing Statement

Appendix 1:
Participant Demographics

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

Gender	
Men	2
Women	11
Total	13
Occupation/Role	
Medical Assistant	2
Administrative Staff	10
Physician	0
RN/BSN	0
Other	1
Total (Participants)	13
Years of Experience	
Mean Years Experience Facility Use of EHR	6.2
All Paper	0
Some paper, some electronic	9
All electronic	4
Total (Participants)	13

Appendix 1:
Participant Demographics

Following is the full participant breakdown (de-identified):

	Part ID	Gender	Age	Education	Occupation/ Role	Professional Experience (Months)	Computer Experience (Months)	Product Experience (Months)	Assistive Technology Needs
1	MP1	F	40-49	Some college	Insurance/ Billing clerk	240+	180-239	48	No
2	JP2	F	40-49	High School graduate	CMA/Front desk	180-239	120-179	60	No
3	KP3	F	50-59	Bachelor's Degree	Manager	240+	240+	72	No
4	JP5	F	40-49	Master's Degree	Executive Director	240+	240+	84	No
5	KP6	F	30-39	Master's Degree	Director of Operations	180-239	240+	48	No
6	MP7	M	30-39	Master's Degree	Practice Administrator	180-239	240+	3	No
7	JP8	F	20-29	High School graduate	Team Lead	0-59	60-119	72	No
8	KP9	F	40-49	Bachelor's Degree	Practice Manager	180-239	180-239	72	No
9	MP10	F	30-39	Some college	Team Lead/MA	120-179	120-179	72	No
10	JP11	F	30-39	Bachelor's Degree	Patient Accounts	120-179	120-179	48	No
11	KP12	F	40-49	Some college	Office Manager	180-239	120-179	84	No
12	MP13	F	40-49	Bachelor's Degree	Clinical Operations Director	240+	240+	12	No
13	KP15	M	40-49	IT Manager	IT Manager	240+	240+	72	No

Appendix 2:
Moderator Guide

Moderator Guide (Test Protocols)

Prep (after general setup)

1. Have browser (Chrome) application open to Acumen login screen

2. Launch Silverback; set up new Project and/or Session (Project: Acumen 7.4, Session: M-P1, etc.)

3. Put printed handout tasks in order for the next participant

Order of test protocols

1. Introductions and welcome (informal)

2. Participant signs two Consent Forms

3. Introductory Verbal Instructions and Additional (Orange sheet)

4. Normative Survey

5. Participant logs in

6. Start recording

7. Give participant printed task handout

8. Read the task(s) for the section

9. Post-task questions:

    a. **Overall, would you say this set of tasks were:** 1—Very easy, 2—Somewhat easy, 3—Neither easy nor difficult,
    4—Somewhat difficult, or 5—Very Difficult?

    b. **How well do you think you understood these tasks?:** 1—Very well understood, 2—Somewhat understood, 3—Neither understood nor didn't understand, 4—Somewhat didn't understand, or 5—Totally didn't understand

10. Ask Subjective Usability Survey (SUS) questions

11. Ask Subjective Satisfaction Survey

12. Read Debriefing Statement (Orange)

13. Give contact card and Swag

14. Prep for next participant (Return to Step 2)

Appendix 3:
Non-Disclosure Agreement and Informed Consent Form

Informed Consent

Fresenius Medical Care – North America would like to thank you for participating in this study. The purpose of this study is to evaluate the Computerized Provider Order Entry features of the Acumen EHR. If you decide to participate, you will be asked to perform several tasks using the software and give your feedback as well as complete two brief surveys. The study will last about 60 minutes.

Agreement

I understand and agree that as a voluntary participant in the present study conducted by Fresenius Medical Care – North America I am free to withdraw consent or discontinue participation at any time. I understand and agree to participate in the study conducted and recorded (audio and video) by the Fresenius Medical Care – North America.

I understand and consent to the use and release of the recordings by Fresenius Medical Care – North America. I understand that the information and recorded files are for research purposes only and that my name and image will not be used for any purpose other than research. I relinquish any rights to the recordings and understand the recorded files may be copied and used by Fresenius Medical Care – North America without further permission.

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 Fresenius Medical Care – North America. 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.

Signature: _____   Date: _____

Appendix 4:
Tasks' Script and Post-Task Surveys

Tasks' script

1. Demographics
1. Locate the chart for your patient and view demographic information including:
    a. Patient's date of birth is 01/15/1960
    b. Patient's birth sex is unknown
    c. Patient's preferred language is English
2. Change the patient's date of birth to 1/15/1961
3. Change patient's birth sex to male.

2. Implantable Devices
1. In the Implantable Device log, add the following device to the list:
   Device ID #00877234000447 with a status of Active/Implanted.
2. Select the device you added in Task One, and change the status to Inactive/Removed.
3. Delete the device added in Task One from the list of devices.

3. Transitions of Care and Clinical Reconciliation
1. One of your roles is to check for CCD (Continuity of Care Documents) that have come to your dashboard from Baptist Hospital. View your list of inbound CCD documents.
2. Open the first CCD document and assign it to the chart for patient John Brown.
3. From your patient's chart, select the inbound CCD sent by Baptist Hospital in order to reconcile the information. Accept the new medication of Norvasc 5mg from the Baptist Hospital list and reconcile.

4. Problem List
1. Locate the chart for your patient and view the existing problem for Chronic Kidney Disease stage 3 on record main.
2. Select the current CKD stage 3 problem and inactive this problem.
3. Add a new problem for Chronic Kidney Disease Stage 4 as an active chronic problem.

Appendix 4:
Tasks' Script and Post-Task Survey (Continued)

5. CDS Workflow Tasks
1. Open to view Clinical Quality Measure (CQM) Alerts from the record main page.
2. You are alerted that your patient has a high BMI. Document that they have receive Diet Education/Counseling.
3. Your patient is a diabetic, and you are alerted that a foot exam is due. Document that your patient has received a pulse, sensory and visual exam.

6. CPOE Laboratory
1. Dr. John Provider has requested that your patient have a BMP and CBC done today. Indicate Dr. John Provider is the ordering provider and the test is to be done STAT.
2. While ordering the BMP and CBC above, also include a task back to yourself as a reminder.
3. Complete the task and the order for the BMP and CBC for the Lab order.

7. CPOE Diagnostic Imaging
1. Dr. Smith has requested that your patient have an ultrasound done today. Indicate that Dr. Smith is the ordering provider and the test is to be done routine.
2. While ordering the ultrasound above, also include a task back to yourself as a reminder.
3. Complete the task and the order for the ultrasound.

Post-task surveys

Impression of ease

Overall, would you say this task was: 1—Very easy,   2—Somewhat easy,

3—Neither easy nor difficult,   4—Somewhat difficult, or   5—Very Difficult?

Impression of comprehension

How well do you think you understood these tasks?:   1—Very well understood,

2—Somewhat understood,   3—Neither understood nor didn't understand,

4—Somewhat didn't understand, or   5—Totally didn't understand

Appendix 5:
Normative Survey

Normative Survey Questions

1. What is your current position and title? _____

2. How long have you held this position? _____

3. Which of the following describes your highest level of education?

    __ High school graduate/GED   __ Some college
    __ Postgraduate (MD/PhD)   __ College graduate (RN, BSN) __ Other

4. Besides reading email, what other activities do you do on the computer?
    __ Access eHR   __ Read the news
    __ Research   __ Shop/bank, etc.   Other: _____

5. About how many hours per week combined do you spend on a computer, tablet, or smartphone (surfing the internet)?   0–10, 10–20, 20–40, or 40+

6. What Internet browser(s) do you usually use?

7. Over the last month, about how often did you use an electronic health record?
    Not at all,   1X a week,   5X a week,   More than 5X a week

8. How many years have you used an electronic health record?

9. How many EHRs do you use or are you familiar with?

10. At your place of work, how are patient records managed, updated and stored?
    __ All paper   __ Mostly paper   __ Mostly electronic   __ All electronic

Appendix 6:
Introductory Verbal Instructions

Introductory Verbal Instructions

Thank you for taking the time to participate in this study. As mentioned in the Informed Consent document that you just signed, you will be performing a number of tasks on the computer. The one request that we would have is that you think out loud. As you are looking around the screen describe what you think, articulate how you are feeling during each task, and express any thoughts or decisions you are making during each task, as well as any points of confusion that you encounter.

We would like you to do these tasks on your own, so we may not actually be able to give you any assistance; however, you are free to use the User Guide at any time. Also, keep in mind that it is all right to fail at a task. If you do, please know that this is a failure of the design and should not be taken as a fault of your own. These errors and points of confusion are actually what we are here to find.

Do you have any questions before we begin? [Pause, and answer any questions] Great! If there is nothing else, let's begin.

Additional Instructions

Welcome to the user study of the various features of Acumen v7.4.

During the next hour you will be given 21 simple tasks to perform. After each task, you will be asked a few simple questions about the task. You may be asked to perform tasks that are outside of your normal profession. If this is the case, please do your best to complete the task as if it was actually part of your current job role.

If you get stuck, you may give up, or, I may ask you to abandon a task and proceed to the next one. In some cases where a task builds on the success of another, I may step in to provide assistance.

Thank you for your decision to participate!

Appendix 7:
System Usability Scale Questionnaire

The following questions are on a scale from 1-5; one being Strongly Disagree and five being

Strongly Agree.

Statement	1	2	3	4	5	n/a	Comments
I think that I like to use this system frequently							
I find the system unnecessarily complex							
I think the system is easy to use							
I think that I need the support of a technical person to be able to use this system							
I find the various functions in this system are well integrated							
I think there is too much inconsistency in this system							
I would imagine that most people would learn to use this system very quickly							
I find the system very cumbersome to use							
I feel very confident using the system							
I needed to learn a lot of things before I could get going with this system							

Appendix 8:
Subjective Satisfaction Survey

Question	Response
What is your overall impression of this system?	
What aspects of the system do you like most?	
What aspects of the system do you like least?	
Were there any features that you are surprised to see?	
What features do you expect to encounter but do not see? That is, is there anything that is missing in this application?	
Compare this system to other systems you have used.	
Would you recommend this system to your colleagues?	

Appendix 9:
Debriefing Statement

Debriefing Statement

The study that you have just completed was designed to investigate the usability of various features of the Acumen EHR. Understanding how users perform on the various tasks using the software will help inform future design changes making the software more intuitive and more easy to use.

This research is required for this EHR to be in conformance with the requirement for Meaningful User certification.

Thank you for your participation. If you have any questions about the study, please feel free to contact me at the email address on this card.