

EHR Usability Test Report of Online Medical Record 2013

Report based on NISTIR 7742 Common Industry Format for Usability Test Reports

Version: Online Medical Record 2013

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1. EXECUTIVE SUMMARY

BIDMC has an internally developed EHR which is a product of a strong and ongoing collaboration with the clinical partners in the hospital. We have active involvement of user groups, a collaborative design process and continuous iteration of system functionality. User groups where we get feedback from include the Ambulatory User Group (AUG), the Housestaff Quality Improvement Council (HSQIC), Medication Safety, QI Directors as well as the Incident Review Teams.

BIDMC Processes can be seen as a Level 4 or 5 Usability Maturity Model where UCD is an iterative process that serves to continually improve the application. We constantly revisit our applications to review workflow, navigation, screen layout and interaction as it applies to particular use cases. These are done as per the guidelines of NIST 7804.

While these processes at BIDMC are ongoing and iterative, this document outlines UCD related summative testing and improvements made in each of the 12 certification areas under 170.315(g)(3) in June, 2019. In accordance with the examples in the NIST 7742 Customized Common Industry Format Template for Electronic Health Record Usability Testing, various metrics were used to evaluate the usability of the software.

Clinical users matching the target demographic criteria served as participants to walkthrough critical use case and identify ways to improve these functions in the EHR. This review resulted in confirming user satisfaction in areas and/or identifying a targeted set of usability improvements

2. INTRODUCTION

The usability testing publically reported for ONC focuses on summative testing and represents a small fraction of the usability design processes at BIDMC. We have a strong partnership with our clinical partners and follow a collaborative usability design process with several user committees and user

groups. UCD at BIDMC is an established, iterative process that serves to continually improve the application. Clinical users routinely send usability suggestions through our feedback systems and Information Systems participates in QI Meetings and findings from Incident Reviews. Since the clinical systems at BIDMC are not available outside of BIDMC, the need to conduct summative testing benchmark against other competing applications is low.

Metrics for the summative usability testing publically reported for ONC were collected in accordance with the examples in the NIST 7742 Customized Common Industry Format Template for Electronic Health Record Usability Testing.

3. METHOD

3.1. PARTICIPANTS

A total of 20 users participated in the study. Participants were selected to reflect current usage of our EHR and were a mix across care settings.

The composition of these groups is per the tables below.

ID	Gender	Age	Education	Occupation/ Role	Dept/ Specialty	Prof. Exp.	Comp. Exp.	BIDMC Clinical Systems Exp.	Assistive Tech Needs
1	Male	30-39	Masters	Physician Assistant	Orthopedics	4	20	2	N
2	Male	20-29	Doctorate	Resident MD	Medicine	3	3	3	N
3	Female	20-29	Doctorate	Resident MD	Medicine	2	19	2	N
4	Male	40-49	Doctorate	Attending, Associate Director of Quality	Medicine	12	16	7	N
5	Male	50-59	Doctorate	Attending	Medicine	20	10	20	N
6	Female	20-29	Doctorate	Resident MD	Medicine	2	6	2	N
7	Male	50-59	Doctorate	Attending	Medicine	22	34	22	N
8	Female	20-29	Doctorate	Resident MD	Medicine	3	3	1	N

9	Female	30-39	Masters	NP	Colorectal Surgery	7	10	7	N
10	Female	50-59	Masters	Director, Nursing Informatics	Nursing Informatics	36	32	32	N
21	Female	30-39	Masters	Analyst	Ambulatory Systems	9	10	5	N
22	Female	40-49	Bachelors	Manager	Ambulatory Systems	16	20	16	N
23	Female	30-39	Bachelors	Manager	Ambulatory systems	9	9	2	N
24	Female	40-49	Doctorate	NP	Internal Medicine / Primary Care	27	27	27	N
25	Male	40-49	Doctorate	PCP, Medical Director	Internal Medicine / Primary Care	12	12	12	N
26	Female	40-49	Bachelors	Director, Ambulatory Systems	Ambulatory	26	20	19	N
27	Male	60-69	Doctorate	PCP	Internal Medicine / Primary Care	25	25	25	N
28	Female	30-39	Masters	NP	Internal Medicine/ Primary Care	4	15	9 months	N
29	Female	30-39	Doctorate	Physician/Medical Director	Medicine/Infectious Diseases	12	16	12	N
30	Female	30-39	Bachelors	Analyst	Ambulatory Systems	23	23	20 months	N
31	Male	40-49	Doctorate	Attending	Internal Medicine / Primary Care	26	23	19	N
32	Female	40-49	Doctorate	Attending	Internal Medicine / Primary Care	25	20	15	N

3.2. STUDY DESIGN

The objective of this study was to measure whether tasks could be completed on our EHR in an efficient, effective and satisfactory manner.

Participants were provided the same instructions and scenarios by the moderators. The following measures were collected for each task for each participant and used to generate usability metrics as per NISTIR 7741

- Task completion success
- Time to complete each task
- Number of unnecessary steps
- Ease of Task ratings

3.3. TASKS

Tasks were identified for each criterion based on realistic scenarios that users would encounter in their typical activities

Following were the scenarios identified

3.3.1 Computerized Provider Order Entry - Medications (A1)

ZZMU2015, TEST1 is a 78 yo male admitted post trans-catheter aortic valve repair. Medical history includes; heart failure, Type 2 diabetes mellitus, HTN, Asthma, hypothyroidism, and chronic lower back pain. Admission orders have been entered by the Intern assigned to Mrs. Whistle.

- Access ZZMU2015, TEST1's Medications
- ZZMU2015, TEST1's blood pressure remains elevated after 3 days. Increase her Nifedipine to 60 mg daily.
- ZZMU2015, TEST1, % constipation. Add Senna 8.6 PO/NG BID PRN Constipation – First Line Bisacodyl 10 mg PO Daily PRN Constipation – Second Line

3.3.2 Computerized Provider Order Entry - Labs (A2)

ZZMU2015,TEST2, is a 50 year old female, transferred to inpatient from the ED complaining of fever/chills and lower back pain. Her temperature in the ED was 102.4. She is being admitted for workup; differential diagnosis including UTI, Pyelonephritis or kidney stones. The lab orders for the floor have been entered.

- Review the labs ordered: CBC, BUN, Creatine, Glucose, Potassium.
- You decide to change the CBC to CBC/Diff and make it STAT.
- Enter a new order for a urine culture.

3.3.3 Computerized Provider Order Entry - Imaging (A3)

ZMU2015, TEST3 a 78-year-old male wheelchair-bound patient who is a s/p fall, arrived at the ED complaining of left leg pain. The ED performed a CT of the left leg, resulted in his chart. The ED also ordered a future dated MRI Angiogram Lower Extremity (Incl. Abdomen & Pelvis).

- Access Imaging Orders on ZZMU2015, TEST3
- You decide to change the MRI to MRI Abdomen & Pelvis w & w/o contrast.
- ZZMU2015, TEST3 is complaining of abdominal pain. You add the following order: Ultrasound of the Abdomen.

3.3.4 Computerized Provider Order Entry - Interaction Checks (A4)

ZZMU2015, TEST4 is a 68 year old male who underwent a right sided L5-S1 Microdiscectomy 2 weeks ago. He now presents with a wound infection. Medical History: HTN, Allergies: Penicillin, Past surgical history: Right knee meniscus tear repair. Patient is seen by Infectious Disease and admitted for IV antibiotic therapy. Surgery recommends bedrest to promote healing of back wound.

- ZZMU2015, TEST4 is on bedrest you order Heparin 5000 units SC BID
(Trigger drug-drug interaction)
- following ID recommendation you order Nafcillin 1 gm IV Q 4 hrs.
(Trigger drug-allergy interaction)

3.3.5 Demographics (A5)

37 year old female presents as a new patient to you. She is an existing patient at BIDMC but is new to you. View her demographics to confirm that it appears correctly, update phone number when she provides her cell phone number as the preferred contact and update sexual orientation.

- Access preferred language, date of birth, birth sex, race, ethnicity
- Access sexual orientation
- Update preferred contact information (phone number)
- Update sexual orientation

3.3.6 Problem Lists (A6)

37 Year old female presents as a new patient to you. She is an existing patient at BIDMC but is new to you. You review her problem list and edit the “Diabetes” problem to add specificity. You also enter Asplenia as a new problem.

- Access active problem list
- Change a problem on the problem list
- Add a problem to the problem list

3.3.7 Medication Lists (A7)

ZZMU2015, TEST5 is a 78 y.o. female who was admitted with a history of Diabetes, HTN, A-Fib, and cerebellar infarction with hemorrhagic transformation. She lives alone and was found by a neighbor on her kitchen floor. After a head CT Scan in the ED she is transferred to the floor. The Intern has entered her Pre-Admission Medication List.

- Access ZZMU2015, TEST5 Pre-Admission medication list
- You notice ZZMU2015, TEST5 Furosemide is listed as QID, after confirming with her daughter you change it to daily.
- You also notice there is no oral hypoglycemic or insulin. Again after confirming with ZZMU2015, TEST’s daughter you add Metformin 500 mg PO Daily

3.3.8 Medication Allergy (A8)

ZZMU2015, TEST6, is a 28 year old male who recently travelled to Cancun. He developed diarrhea and abdominal pain and he was prescribed Bactrim. He now presents with a full body rash after 3 days of treatment.

- Review ZZMU2015, TEST6’s allergy list.
- ZZMU2015, TEST6 has Penicillin as an allergy however there are no common reactions listed. After confirming with the patient you update the common reactions.
- Add Bactrim to ZZMU2015, TEST’s medication allergy list with the appropriate reactions.

3.3.9 Clinical Decision Support (A9)

37 year old female is a new patient to you, but not a new patient to BIDMC. Patient has Asplenia on the problem list. Patient also has a med allergy to Penicillin and a prescription for Simvastatin. You are confirming the decision support tools that are associated with problem lists, medications and medication allergies

- You have already documented Asplenia on the patients problem list. Verify that Men B reminder is triggered and displays
- Place a medication order for Simvastatin 40mg QD. Confirm alert appears showing duplicate drug (as drug already appears on med list)
- Enter a prescription for Penicillin. Confirm allergy alert appears and you are asked to override the alert

3.3.10 Implantable device list (A10)

37 year old female presents as a new patient to you. She is an existing patient at BIDMC but is new to you. In the course of the exam she mentions that she had cardiac surgery 3 years ago and she couldn't remember the type of device she had implanted. You access the "implantable device link" to view the information

- Review information for an implantable device

3.3.11 Clinical information reconciliation and incorporation (A11)

37 year old female presents as a new patient to you. She is an existing patient at BIDMC but is new to you. You are looking for additional historical context and access the "CCDA" to see if there is any additional information.

- View CDA Information

50 year old female, TURNERZ,SUSAN is an existing patient at BIDMC and has a visit at another facility. You are now reconciling her problems, medications and allergies in the BIMDC Medical Record

- Receive and Reconcile CDA Information

3.4. PROCEDURES AND TEST LOCATION

The testing was performed at BIDMC in conference rooms using workstations that reflected the typical clinical setup for target users.

Participants were greeted by a moderator and oriented to the testing computer and guidelines. Participants were then assigned a participant identifier in order to de-identify results.

Participants were given access to the test system and asked to perform the tasks selected for testing. In cases where there were multiple ways to achieve a task, testers were not directed to follow a specific path. To better simulate real world performance, participants were told they are free to accomplish the task in whatever manner they prefer.

Before each task, the moderator gave participants a written copy of the task and oral instruction. A walkthrough of functionality was included when research indicated that not all users were familiar with the testing setup used. Task timing began and ended when the participant reached particular predetermined points in the task.

3.5. TEST ENVIRONMENT

Testing was conducted at the hospital facility using hospital workstations that were configured in the same manner as workstations used for clinical care.

3.6. PARTICIPANT INSTRUCTIONS, TEST FORMS, TOOLS

The moderator read general introductory statements and instructions aloud to the participants before administering the test. The participant was then asked to complete a number of tasks that were read aloud by the moderator and provided on paper to the participant for reference.

During the study demographics were captured using the Participant Demographic Information in Appendix A

Participants were given access to the functionality and asked to perform tasks. They were asked to rate usability of tasks identified, and to offer any suggestions to improve the usability of the system.

3.7. USABILITY METRICS AND DATA SCORING

As per the guidelines of NISIT 7741 (NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records), the goals of our test was to assess the effectiveness, efficiency, and satisfaction with which the intended users can achieve their tasks in the intended context of product use.

The following table details how metrics in these 3 areas were captured.

Measure	Detail
Effectiveness Task Success - Mean (%)	A task is considered a success if the participant achieves the defined task outcome without assistance. The total number of successes are calculated for each task and then divided by the total number of times that the task was attempted. The results are presented as a percentage.
Effectiveness Task Failures - Mean (%)	The task failure percentage can be calculated by subtracting the binary task completion rate from 100.
Efficiency Task Path Deviation -	The number of steps in a participant's path through the application is recorded and compared to the number of steps in the closest acceptable

Observed #	path. An extra step is recorded if the participant performs a step that is not included in the defined path but is also not counterproductive to completing the task. The total number of steps taken by a participant is counted and the difference between the steps in their path and the closest defined path is calculated. The average of the differences for the participants is calculated. Only extra steps for tasks that were successfully completed are included in the average extra steps per task analysis and standard deviation.
Efficiency Task Time Mean (seconds)	Each task is timed from a predetermined starting point until the participant reaches the predetermined end point for the task or verbalizes completion. Only task times for tasks that were successfully completed are included in the average task time.
Satisfaction Task Rating - Scale Type	The participant's subjective impression of the ease of use of the application is recorded for each task. After each task was completed, the moderator asked the participant to rate the task on a 5-point Likert scale: 1 (Very Difficult), 2 (Somewhat Difficult), 3 (Neither Difficult nor Easy), 4 (Somewhat Easy), 5 (Very Easy). These values are averaged across participants for each task .

4. RESULTS

4.1. Computerized Provider Order Entry - Medications

4.1.1. Data Analysis and Reporting

CPOE - Medications	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Access Medications	100	0	3.3	1.8	5
Change Medications	100	0	16.3	2.8	4.8
Add New Medications	100	0	23.7	5.3	4.7

4.1.2. Findings and Areas of Improvement

Everyone found it easy to find the orders from the profile with fewer clicks now. Some said that it was nice to be able to add and edit meds from the same place. One user said that it was easy to access viewing abnormal vitals before adding or changing meds.

One user said that it would be nice to have one screen with home meds, active meds and administration summary. Another user said that they had to scroll within Order screen to hit OK which was undesirable..

4.2. Computerized Provider Order Entry - Laboratory

4.2.1. Data Analysis and Reporting

CPOE - Laboratory	Effectiveness	Efficiency	Satisfaction
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	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Review Labs	100	0	10.3	2.5	4.1
Change Lab Order	100	0	21.2	5.4	4.3
Add new Lab Order	100	0	21.8	5.5	4.2

4.2.2. Findings and Areas of Improvement

Most said that they could achieve this with fewer clicks in the new streamlined view. Access to order sheet was quite easy and they liked that the allergies are listed upfront.

Some indicated that it would be nice to see pending labs as well as have a direct link to Lab ordering screen from the profile. One user felt that it was still a lot of clicks. Some users thought that we should make it clearer that the view of orders was a static view and not directly editable.

4.3. Computerized Provider Order Entry - Diagnostic Imaging

4.3.1. Data Analysis and Reporting

CPOE - Diagnostic Imaging	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	
					5 = Very easy

	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Access Imaging Orders	100	0	8.4	1.7	4.3
Change Imaging Order	100	0	38.5	5.4	4
Add new Imaging Order	100	0	26.4	7.2	4.5

4.3.2. Findings and Areas of Improvement

A couple of folks said that the MRI Abdomen was slightly hard to find and they had to search for it. However they liked the ease of changing as well as the fact that orders are available upfront. Some said that it would be nice to include a brief list of pending radiology orders as well as have the ability to go directly to Imaging/Radiology order from profile. Some said that when viewing past orders, we should consider showing just active orders as the default rather than all orders. A user also said that going to Enter Orders to view all Active orders was not intuitive.

4.4. Drug-drug, drug-allergy interaction checks for CPOE

4.4.1. Data Analysis and Reporting

Drug-drug, drug-allergy interaction checks for CPOE	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean	Mean	Mean	Mean	Mean

	(%)	(%)	(seconds)		
Drug-drug interaction	100	0	17.8	3.5	4.4
Drug-allergy interaction	100	0	28.6	6.7	4.6

4.4.2. Findings and Areas of Improvement

Most said that it was easy to see interactions as well as level when it was a popup. Some said that the higher level interactions and allergies on the side may not be as obvious and could be missed. One user asked if the override reason be listed as part of order.

4.5. Demographics

4.5.1. Data Analysis and Reporting

Demographics	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Access preferred language, date of birth, birth sex, race, ethnicity	100	0	21.1	0.4	4.9
Access sexual orientation	100	0	10.2	0.6	4.6
Update preferred contact information (phone number)	100	0	24.4	1.8	4.8

Update sexual orientation	100	0	14.3	1	4.8
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4.5.2. Findings and Areas of Improvement

Users said that it was easy to navigate to demographics. Finding sexual orientation was hard since not everyone uses the sheets tab and it may perhaps be good to include in the body of progress note. Sexual orientation was also slightly confusing.

Users asked to add birth sex to demographic and social history screen. One user asked if the 'Edit' button could be moved to the left of Social history so it is easier to find.

4.6. Problem List

4.6.1. Data Analysis and Reporting

Problem List	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Access active problem list	100	0	3.1	0.4	5
Change a problem on the problem list	100	0	15.5	0.8	5
Add a problem to the problem list	100	0	12.5	0.3	5

4.6.2. Findings and Areas of Improvement

Users said that it was easy to navigate to Problem Lists. One user suggested that 'Last Verified' should auto update and not need a separate click.

4.7. Medication List

4.7.1. Data Analysis and Reporting

Medication List	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Access Pre Admit Medication List	100	0	3.4	1.5	4.8
Delete med from Pre Admit Medication List	100	0	6.3	2.5	4.8
Add new med to Pre Admit Medication List	100	0	11.8	2.2	5

4.7.2. Findings and Areas of Improvement

Everyone unanimously agreed that the PAML was much easier to find and with much fewer clicks. They also liked that it was available front and center on profile as well as on the Medications tab.

One user asked if it would be great if the PAML opened up in a new window to make it easier to cross reference PAML with active meds.

4.8. Medication Allergy List

4.8.1. Data Analysis and Reporting

Medication Allergy List	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Review Allergies	100	0	3.6	0.8	4.9
Update Allergies	100	0	14.7	1.3	4.8
Add new Allergy	100	0	17.9	3.3	4.8

4.8.2. Findings and Areas of Improvement

Almost everyone liked the fact that the Allergies are written clearly, red and bold in center of screen. They also liked that allergies were easily accessible from profile. One user asked if we could remove prompt for password when updating allergies.

4.9. Clinical Decision Support

4.9.1. Data Analysis and Reporting

Clinical Decision Support	Effectiveness		Efficiency		Satisfaction
	Task	Task	Task Time	Average	
					5 = Very easy

	Success	Failure		Unnecessary steps per task	
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Trigger Men B reminder	100	0	2.3	0.1	5
Duplicate drug alert	100	0	26.1	3.2	4.8
Allergy Alert	100	0	32	1.7	4.8

4.9.2. Findings and Areas of Improvement

Alerts are obvious. Some suggested that it would be nice to see Alerts without clicking on them.

4.10. Implantable Device List

4.10.1. Data Analysis and Reporting

Implantable Device List	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
Review implantable device information	100	0	13.4	0.3	4.1

4.10.2. Findings and Areas of Improvement

One user asked if the Implantable device link could be made available from the 'All' tab. Another user said that while the information was

easy to review, it was difficult to know when it existed and perhaps it could be highlighted in some way.

4.11. Clinical information reconciliation and incorporation

4.11.1. Data Analysis and Reporting

Clinical information reconciliation and incorporation	Effectiveness		Efficiency		Satisfaction
	Task Success	Task Failure	Task Time	Average Unnecessary steps per task	5 = Very easy
	Mean (%)	Mean (%)	Mean (seconds)	Mean	Mean
View CDA Information	100	0	5.1	0.9	4.8
Receive and Reconcile	100	0	190.3	0.4	4.3

4.11.2. Findings and Areas of Improvement

One user asked if the CDA link could be made available from the 'All' tab. Users felt that the receive and reconcile was a huge improvement to getting outside data. Some wished they could do this for ED and discharge meds too. Some users said that when displayed the reconciled data in the EHR it would be great to see provenance or the origin of data.

5. RESULTS CONCLUSION

- While clinical partners have worked hand in hand with Information Systems to enhance our systems, it is important to periodically step back and assess the usability of the system as a whole.
- For the scenarios in the Inpatient setting, we noticed that the number of unnecessary clicks was significantly larger than optimal. This was because we conducted our tests on a version that was being piloted in June. This version of the software was designed specifically to improve usability and reduce clicks. However many users were not aware of the capabilities of the new system. Training and communication is an important aspect to improving usability.
- Data Accessibility across Care Settings is critical to get a holistic picture of the patient.