

SI 622

Evaluation of Systems and Services

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Organ Transplant Information System (OTIS)

Usability Test

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1. Introduction

This report presents a usability evaluation of the Organ Transplant Information System (OTIS) in use at the Transplant Center of the University of Michigan Health System (UMHS). The evaluation involves actual usability testing of the system by four post-operative nurses at the Transplant Center who currently use OTIS. All four usability tests were conducted separately. This evaluation is part of an overall project to assess the functionality, usability, and aesthetics of OTIS.

This document begins with a brief overview of the system and a description of the target population. Next, our evaluation goals and methods are presented. These are followed by our detailed findings concerning the usability, functionality, and aesthetics of the system. Recommendations addressing some of the issues identified through this evaluation are provided. Lastly, the conclusion summarizes the significant findings and the implications of these for the design of OTIS.

1.1. Overview of OTIS

OTIS is used at the UMHS Transplant Center to evaluate potential transplant recipients and monitor their lab results, diagnoses, and other medical data before and after transplant surgery. The types of transplants performed at the center include kidney, heart, lung, and pancreas. While OTIS is used for specialized transplant information, Transplant Center providers and other staff members also refer to CareWeb -the web-based electronic medical record system developed specifically for clinicians and clinical support staff at the UMHS- for more general patient record data. Both systems draw from the same Clinical Data Repository (CDR), which contains electronic medical records of patients.

People in many Transplant Center roles use OTIS (e.g., care coordinators, surgeons, nephrologists, inpatient and outpatient nurses, social workers). Although not every feature of OTIS is equally used by those in different Transplant Center roles, all qualified users have the same read security access to the patient record.

The top level features of OTIS's patient record application, and a brief description of each, are provided in Table 1. When a user logs into the system, the staff home page gives the option to search for a patient. Once a patient is selected, the record view defaults to the Timeline feature. All other features may be accessed through menu options.

Our initial understanding of OTIS was based on an interview with the business analyst in charge of the system, as well as on interacting with a marketing demo with a dummy database. A heuristic evaluation of OTIS was also conducted by our group using the marketing demo, taking into consideration both the single user and collaborative aspects of the system.

Top Level Feature	Description
*Timeline	An icon-based chain, where each icon represents a chain of events.
*Viewer	A full view of each patient contact by day, with medications, labs, open issues, and other detailed information in one large scrollable chart
Issue List	A queue of open issues by program clinic
*Notes	Transplant-specific notes editing and viewing feature
*Demographics	Patient contact info, referring physician, and diagnoses
Flowsheet	
*Medications	Matrix of medications cross-referenced by date
*Labs	Detailed results of labs with a variety of filtered views
Diagnostic Study	Diagnoses that have been made by test results
Virology	Summary of virology and immunology results
Biopsy	Summary of biopsy results
Radiology	Summary of radiology test results
DMI	Documents drawn from the Clinical Data Repository (these are in CareWeb too)

Table 1. Top level features of OTIS's patient record application. We highlight the features specifically evaluated in the usability test.

1.2. Target Population

Individuals with various Transplant Center roles utilize OTIS. These include, but are not limited to, care coordinators, surgeons, nephrologists, inpatient and outpatient nurses, and social workers. The target population for the usability evaluation itself consisted of post-operative nurses in the Kidney Transplant Clinic. All nurses were involved in outpatient treatment. Test participant selection and recruitment are presented in detail in the Methods section of this report.

2. Usability Test

2.1. Goals

Our group initially conducted a heuristic evaluation of OTIS to identify some of the major usability problems of the system. Although this method allowed us to pinpoint some of the single user and groupware usability issues, we wanted to confirm our findings and determine if additional problem areas exist. Actual usability testing is the ideal way of identifying the usability issues in a system through tasks designed to simulate the typical user experience. Therefore, we conducted a series of usability tests with current users of OTIS. Our goals were to evaluate the system in terms of overall usability, functionality, and aesthetics, through direct observation of the user experience.

2.2. Methods

The methodology followed for the usability evaluation involved the development of tasks consistent with the actual usage of the system, the selection and recruitment of test participants, the preparation of pre- and post-test questionnaires for gathering background information and

feedback, planning of the physical set-up for the tests, conducting user testing, and the organization and analysis of the data collected. The details of each component are presented in subsequent sections.

2.2.1. Task Scenarios

Task scenarios were based on issues identified and concerns raised in the group's earlier heuristic evaluation of OTIS. Two tasks involving a series of specific sub-tasks were developed to test the usability and some of the functionalities of the major features of the system, including the Timeline, Demographics, Medications, Labs, and the Viewer. Since some information associated with the tasks can be found in more than one location through multiple features of OTIS, the tasks also allowed us to observe the preferred methods of each user, and their overall interaction with the system. The task scripts as used in the usability tests are presented in Appendix A. These tasks were reviewed and approved by Drs Joseph Norman and Silas Norman from the UMHS for both relevancy and validity. Briefly, the goal in designing each sub-task was to identify whether information can be readily found through the system, how user interaction occurs with each given feature, or whether problems concerning accurate data entry exist.

2.2.2. Questionnaires

Two sets of questionnaires were developed to gather background information on test participants, and to obtain feedback on their experience with OTIS. The pre-test questionnaire, administered to the participants immediately before the usability test, was designed to acquire some demographic information, information on the participant's job profile at the Transplant Center, and on their usage and experience with OTIS. The participants were asked to fill out the pre-test questionnaire in writing.

The post-test questionnaire, administered to the participants immediately after the usability test, was designed to acquire qualitative information on their experience with each of the tested features of the system. This questionnaire was administered orally to allow for clarification of comments and follow-up questions.

Both questionnaires can be found in Appendix B (please see Section B.1. of Appendix B for the pre-test, and Section B.2. of Appendix B for the post-test questionnaire).

2.2.3. Participant Selection and Recruitment

We started out the participant selection process by considering all groups of potential users according to the target population of the system. We decided to recruit all participants from a single job role within the Transplant Center to keep the job title variable constant, and to increase our sample size in observing whether certain issues arise consistently in the system's support of a given group of users. Considering scheduling issues and the limited timeframe to conduct the tests, post-operative outpatient nurses were selected as the target population for the usability evaluation.

Potential participants were identified through recommendations by Drs Joseph Norman and Silas Norman. Each of these potential participants were then contacted via email to ask if they would be willing to participate in our usability evaluation of OTIS. Non-respondents were further

contacted by phone. A total of five users responded to our requests and four of them were recruited for the usability tests. Usability testing with each participant was conducted separately in four approximately 40-45 minutes sessions. Tests took place on April 2, 2007; April 3, 2007 (two tests were conducted on this day); and April 4, 2007.

2.2.4. Physical Setup

We wanted the usability test participants to feel as comfortable as possible in the environment in which the testing would take place. Considering this, as well as scheduling and commuting difficulties, our group decided to conduct the tests at the University of Michigan Hospital, where the participating nurses could take about an hour off their shifts for the user testing of the system. A conference room in the Hospital was reserved for all four of the tests conducted. The set-up included a laptop with the marketing demo used by our group for the heuristic evaluation of OTIS. Two dummy patient records, one under the name Ricardo Nunez and the other under Charlotte Aster, were created in an earlier version of OTIS for the evaluation tasks. Differences between this version and the current version were noted earlier to prevent problems in task design and system evaluation. The setup also included instruments for the audio and video recordings of test participants. Camtasia was used for screen capture and recording as participants completed their tasks.

Two of our group members were present in each of the usability tests conducted. Testing began with a group member reading an introductory script to the test participant, explaining the goals of the evaluation and how the test would be conducted. This script is presented in Appendix C. Participants were provided with a project information sheet introducing our group, the project, and the confidential and voluntary nature of the usability tests in which they were participating. They were given a copy of this sheet to keep, and were asked to sign an informed consent form containing the same text. Participants were also asked in a separate document whether they would consent to the different data capture methods we would be using – such as audio, video, and Camtasia. Please refer to Appendix D for the project information sheet and the informed consent forms used for the user testing. Written consent was obtained for all data capture techniques from three of the participants. One participant did not consent to video-recording, but agreed to the rest of the data capture techniques.

After project information was given and informed consent was obtained, participants were asked to complete the pre-test questionnaire, followed by the two task scenarios. The post-test questionnaire was administered orally by one of our group members upon completion of tasks. Test participants were provided with \$20 Borders gift certificates for participating in the study.

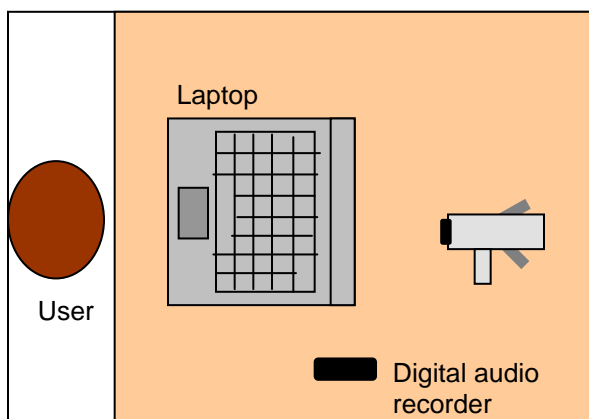


Figure 1: Usability test setup in conference room at Taubman.

2.2.5. Data Analysis

All data recorded by video and Camtasia were synchronized for analysis. The group focused mostly on assessment of the system's usability and functionality. Task design and the post-test questionnaire focused less on the aesthetics of the system, as this seemed to be of secondary importance to supporting the workflow in the Transplant Center through the EMR's available features.

Evidence from observers' notes, Camtasia recordings, visual and audio data, and the pre- and post-questionnaire information were all compiled to identify functionality and usability issues, and to confirm findings from our earlier heuristic evaluation of the system. The findings are presented below under separate sections for usability and functionality. Recommendations are also presented for recurring issues that were identified. All gathered data were anonymized where possible.

3. Findings

Observation of the visual and audio information from the usability tests, in addition to participants' comments and observers' notes helped the team determine the level of functionality and usability of OTIS, as well as the impact of the aesthetics of OTIS on the satisfaction and efficiency of its users.

3.1. Functionality

Our assessment of the functionality of OTIS focuses mainly on the ease of use of the features in accomplishing tasks. We present these results organized by features - with recommendations for change where appropriate. We also note a few system wide observations as well.

3.1.1. Overview of Functionality

OTIS exists in part to replace the past process of retrieving patient information from paper-based documents or by asking other caregivers. OTIS presents significant time savings compared to the old process. Not all patient information, however, is accessible through OTIS (e.g., patient appointment history). Such information is accessible from CareWeb. While all test participants found the features reasonably easy to use, all complained about the lack of communication between OTIS and CareWeb.

3.1.2. Feature Analysis

Our team designed our task with focus on testing the following features.

3.1.2.1. Timeline

Our subjects were familiar with the functionality with this feature. They were able to retrieve information correctly here.

Transplant Staff Page

Name ASTER, CHARLOTTE MARIE **POD** 1.3 yrs **Type name or Reg #** **Go**
Reg ID 9001 080 3 **Birthdate** 05/14/45 (61)
Dx Reflux nephropathy (K) **Gender** Female **Last name, First name**

Study

Timeline **Viewer** **Issue List** **Notes** **HELP**

Demographics Flowsheet Medications Labs Diagnostic Study Virology Biopsy Radiology DMI

Add New Event

UM Primary Caregiver Irina Sadovskaya-Darlington

Dialysis Off

Print Facesheet Reports
Census Lists
Maintenance Menu

08/04/03 → 10/01/03 → 12/25/05

LR

Figure 2: Timeline Feature

3.1.2.2. Medications

Overall, the participants liked the fact that they could edit the dosage of the medicines through the system: they did not have to find and edit paper documents. Generally, the participants found this feature easy to use. The simplified fields without titles did not cause any confusion. One participant, however, mentioned it would be better if the ability to add two different frequency of dose to the same drug was available. We noticed that our participants tracked the change in dosage history manually through the tabulate data. This might lead to human errors in decision making. Moreover, not all the records were listed in the same page (users need to click through “next 5” or “previous 5” record). One participant could not identify the dosage change made in the test because it was on the previous page.

Recommendations: To be more descriptive, a graphic that depicts the history of dosage of medicine should be helpful for tracking. On the graphic, the points of prescription given should be clickable and changeable.

The screenshot displays a patient record for ASTER, CHARLOTTE MARIE. Key details include:

- Name:** ASTER, CHARLOTTE MARIE
- Reg ID:** 9001 080 3
- Dx:** Reflux nephropathy (K)
- POD:** 1.3 yrs
- Birthdate:** 05/14/45 (61)
- Gender:** Female

 A search bar is present with the text "Type name or Reg #" and a "Go" button. Below this is a navigation menu with tabs for Timeline, Viewer, Issue List, Notes, Demographics, Flowsheet, Medications, Labs, Diagnostic Study, Virology, Biopsy, Radiology, and DMI. The "Medications" tab is active, showing a table of medications.

POD	1.3 yrs	1.2 yrs	1.2 yrs	172	41
Date	04/04/07	03/12/07	03/08/07	06/15/06	02/04/06
TACROLIMUS			ON-HOLD	1.5 mg PO BID	2 mg PO BID
Myfortic	320 mg PO BID	320 mg PO BID	320 mg PO BID	320 mg PO BID	220 mg PO BID
PREDNISOLOE					4 mg PO Daily
Colace	100 mg PO BID	100 mg PO BID	100 mg PO BID	100 mg PO BID	100 mg PO BID
Ditropan	15 mg PO BID	15 mg PO BID	15 mg PO BID	15 mg PO BID	15 mg PO BID
FLUCONAZOLE	100 mg PO Daily	100 mg PO Daily	100 mg PO Daily	100 mg PO Daily	100 mg PO Daily
Lipitor	15 mg PO Daily	10 mg PO Daily	10 mg Daily	10 mg Daily	10 mg Daily
Lopressor	100 mg PO BID	100 mg PO BID	100 mg PO BID	100 mg PO BID	100 mg PO BID
Macrobid	100 mg PO Daily	100 mg PO Daily	100 mg PO Daily	100 mg PO Daily	100 mg PO Daily
HYSTATIH	4 ml PO QID	4 ml PO QID	4 ml PO QID	4 ml PO QID	4 ml PO QID
Phenergan	25 mg PO PRN	25 mg PO PRN	25 mg PO PRN	25 mg PO PRN	25 mg PO PRN
Staff Initials	tA	tA	tA	tA	tA

Figure34: Medication feature

3.1.2.3. Viewer

This is a new feature therefore only one participant knew about it. The participant commented that the Viewer was useful because it displayed all of a patient’s relevant vitals on one page.

3.1.2.4. Demographic

We found our participants did not realize what to look for within this section. For example, none of the users attempted to find the referring physician of the patient in this section. The reason might be that the vocabulary “Demographic” for OTIS users does not correspond with treatment information.

Recommendation: The title of this section should be redefined. Since the information within this section is about the personal appointment and diagnoses, a more descriptive title such as “Contact & Diagnoses” will be more appropriate.

3.1.2.5. Labs

Generally, our participants understand how to use the lab part to check patients’ to keep track of patients’ physical condition. They seemed to be used to the tabulate data (Figure 2). However, as we mentioned in medication section, human error could be reduced if there is graphical representation for the lab results.

Recommendation: Providing graphical representation with timeline information in lab results. Caregivers will get a better of the transition of patients’ condition.

The screenshot displays the OTIS system interface for a patient named Aster, Charlotte Marie. The patient's information includes: Name: ASTER, CHARLOTTE MARIE; Reg ID: 9001 080 3; POD: 1.3 yrs; Birthdate: 05/14/45 (61); Gender: Female; Dx: Reflux nephropathy (K). A search bar is present with the text 'Type name or Reg #' and a 'Go' button. Below this, there are navigation tabs for 'Timeline', 'Viewer', 'Issue List', 'Notes', 'Demographics', 'Flowsheet', 'Medications', 'Labs', 'Diagnostic Study', 'Virology', 'Biopsy', 'Radiology', and 'DMI'. The 'Labs' tab is active, showing a list of lab categories: Standard, Secondary, Arterial Blood Gases, Hematology, Urinalysis, ABO, MELD/PELD, PRA, GFR, and PFT. A 'Printable Version' link and an 'Add Outside Lab' button are also visible. Below the navigation is a table titled 'Standard Lab Results' with a subtitle 'Baseline Creatinine 1.3'. The table has columns for 'Date' and various lab tests including CsA, CsA2, Tacro, Rapa, Creat, BUN, Ha+, K+, Cl-, CO2, URIC, Gluc, A1C, Amyl, Lip, Ca++, iPTH, PO4, Alb, Prot, ALk0, LDH, AST, and ALT. The table contains three rows of data for dates 02/04/06, 01/30/06, and 12/03/03.

Date	CsA NG/ML	CsA2 NG/ML	Tacro NG/ML	Rapa NG/ML	Creat MG/DL	BUN MG/DL	Ha+ MEQ/L	K+ MEQ/L	Cl- MEQ/L	CO2 MEQ/L	URIC MG/DL	Gluc MG/DL	A1C %	Amyl IU/L	Lip IU/DL	Ca++ MG/DL	iPTH PG/ML	PO4 MG/DL	Alb GM/DL	Prot GM/DL	ALk0 IU/L	LDH IU/L	AST IU/L	ALT IU/L	T M
OUT 02/04/06 08:00			6.2		1.3	24	142	4.3	108	26		93	6.2	52	66	9.1		4.4	4.2		142	275	22	34	
OUT 01/30/06 08:00			5.5		1.3	20	140	5.1	108	27		90		36	54	9.6		4.3	4.1	6.2	78	224	24	34	
OUT 12/03/03 11:00												160													

Figure 4: Labs feature

3.1.2.6. Notes

It was surprising to find that our participants had various expectations of the information that is saved in the notes sections. In several tasks, such as identifying a referring physician or a social worker, our participants went to the notes section for the answer. We found it hard to define what kind of information should be in notes because each user had a different expectation of what that section should contain. However, the fact that they turned to “notes” to look for information that is actually in other sections compromises the efficiency of the system: finding information in “notes” requires eye scanning dense text blocks which can be both time consuming and hard on the readers eyes.

Recommendation: It is hard to define what to put in the notes. However, to clarify the source of information, a comprehensive list of the content of the system should be created and uploaded to the server for search online.

3.1.3. OTIS-wide Functionality

Test participants all claimed that OTIS has improved their efficiency. They liked that OTIS allows them to accomplish what they need to do. According to one of the test participants, the tasks our team designed are “what we do all day” and OTIS did contain almost all the information and functionality they need. Although the test participants took different routes to their goals (details will be discussed in the usability section), they were able to complete their tasks.

As noted above, OTIS does not provide all of a transplant patient’s record. OTIS users usually end up looking for missing pieces of information in CareWeb or by asking the doctors. For example, to cross-reference a dosage change with an appointment, users need to refer to CareWeb for the appointment history, thus breaking the flow of that task. Also, OTIS cannot display multiple tabs - such as lab results and medications - on one screen. Users have to either switch between windows or memorize the information. Memory load problems arise in these situations and can lead to mistakes in the decision making process of an OTIS user.

3.1.4. OTIS and CareWeb Integration

Test participants identified lack of communication with CareWeb as a major functional hurdle in OTIS. In all the tests, participants commented that they relied on the DMI (documents from CareWeb) for retrieving some necessary patient information – for example, the patient’s current appointments or the type of patient (in/out) - while working in OTIS. In addition, the medical records within OTIS are not accessible from CareWeb, thus, OTIS users are forced to create duplicate documents for both systems. Patient record inconsistencies arise when users forget to write their notes down in both systems.

3.2. Usability

Our test was primarily concerned with identifying usability issues with OTIS. We present these results organized by task, as appropriate, with a few system wide observations as well.

Overall, users consistently completed the following tasks without any difficulty:

- looking up the patient,
- checking for potential side effects of medications,
- adding a medication,
- locating the date dialysis was terminated,
- checking which drug doses were changed,
- identifying which kidney was transplanted,

Other tasks exposed opportunities to improve OTIS’s usability.

3.2.1. Task Effectiveness

We logged how effectiveness users were in completing the tasks. The result is as follow.

	S: Succeed at the first attempt	TE: Tried and Succeed	F: Failed	
	User 62	User 82	User 100	User 101
Task1				
Finding the Patient	S	S	S	S
Referring physician	TS	TS	TS	TS
Identify drugs with side effects	S	S	S	S
Determine possibility of rejection/ infection	S	S	S	S

Task2				
Finding the patient	S	S	S	S
Diagnosis prior to transplant	S	S	S	S
Last time took Prednisone	S	S	S	S
Add Ambien	S	S	TS	S
Change the dose of Lipitor	S	S	S	S
Check regular drug doses	F	F	F	F
Finding Care coordinator	S	S	S	S
Finding social worker	F	F	F	S
Dialysis termination	S	S	S	S
Finding Which kidney was transplanted	S	S	S	TS

Table 2: Task Effectiveness

3.2.2. Identifying the referring physician

In our test, users took varying routes to identify the referring physician for a particular patient. Three nurses first attempted to find the information in Notes/DMI, which they said is where they usually find the information. Our demo setup did not show the referring physician in the notes (as sometimes happens).

At this point, users tried varying other approaches, including the timeline (for the transfer event), the reports, the facesheet, and the demographics. All users eventually located the information in the demographics view, but many commented that they were unable to tell if this physician was still following the patient or even if it was the most correct option.

While users were able to identify the physician, we still feel that this feature indicates problems: the same piece of information can be answered through different steps (generally a good design method), but each method can give different results!

Specific recommendations from these observations:

- If different methods can be used to reach or edit the same fact, all should point to the same place in the database in order to increase findability and reduce errors.
- Names on the facesheet should indicate roles of the caregivers involved.

- OTIS designers should investigate a way to indicate whether or not any given caregiver is still actively involved with a patient rather than requiring users' to infer this data from other entries in the medical record.

3.2.3. Identifying diagnose prior to transplant

As with identifying the referring physician, there were many pathways to this information. Locating the pre-transplant diagnosis was not as challenging as the other task. Half of the nurses went to demographics and diagnoses, and the found the information via the timeline facesheet. If this information is consistent it is not a problem. Frustration can quickly increase if information is inconsistent (such as between DMI notes and the facesheet).

We saw this frustration when we asked the users identify all diagnoses. Three users said they did not know if the information was aggregated anywhere, while the fourth said she would use CareWeb to locate the information and gave up. Within the confines of OTIS, three nurses tried three different approaches. One went to DMI summary and medications and then listed the conditions that resulted in the medication the patient was on. Another also went to DMI, checked a date, and read relevant information but was unable to identify actual diagnoses. The third tried to find the information in demographics/diagnoses, but when it was not there she gave up.

One nurse questioned whether she would ever need to identify all diagnoses, pointing out a potential problem in our task design.

3.2.4. Finding when and how a dosage was changed

All users were able to quickly locate a partial answer quickly using medications view. All found this information to be incomplete, though, as it does not show at what time the dosage was changed – this information can sometimes be important, and can sometimes be found in DMI notes. Two nurses also mentioned that they like to check the notes to see why the medication was changed, something else not shown in OTIS's medication information. One nurse also mentioned that sometimes the context for when a medication changed is helpful information, and she currently has to go to CareWeb to view the appointment history.

Suggestions from this task:

- Increase the resolution of the medications panel to allow nurses to enter when a medication was stopped. If implemented, this should not default to a specific time but to a lower resolution (i.e., the date) or it could accidentally convey incorrect information when only a date for the medication change is entered.
- Examine ways to better link notes about why and when a medication was changed to the view in the medications page. This may be something as simple as linking directly to the notes for that day in a pop-up window or may involve more complex matching of medication names between the medication information and text in the notes.

3.2.5. Identify the care coordinator

As with identifying the referring physician, there are multiple ways to access this information. Some found it in the evaluation information, while others tried the timeline and discovered that the entry was blank. Additionally, UMHS uses a rotation system for post-transplant coordinators.

OTIS seems designed for a consistent post-transplant caregiver, so this information is usually not entered in the first place, and if it was entered, is often out of date.

Suggestions from this task:

- Information about the care coordinator should point to the same entry in the database.
- The data model for the care coordinator should be updated to reflect the real-world practice of rotating the coordinator (so long as UMHS continues this approach).

3.2.6. Adding a social worker to a patient record

All four nurses commented that adding a social worker is a pre-operative task and not something they do. This fault in our task design did give us the opportunity to see how some OTIS users respond when asked to complete a new task with which they are unfamiliar. Two users gave up immediately after recognizing that this not something they do. One tried to add the social worker as an “other contact” in the demographics screen but gave up. Of the three that gave up, two suggested that they might add the information using a CareWeb note.

The fourth nurse also said she does not normally add social workers to a record but persisted with the task. Like the other nurse who made an attempt, she navigated to the evaluation report and tried the other contact field. Seeing that this was not the right location, she tried again and reached the “evaluation team” feature. She quickly identified the edit button and added the social worker.

These results raise the question of whether or not OTIS could be designed in a way to make functionality more visible and encourage exploration of features. We do not have any specific recommendations, but if this were to happen, the nurses may have been more likely to attempt the task. On the other hand, for medical support systems, we can understand wanting to discourage users experimenting with features until they have had training. Finally, these results may be more of a reflection on OTIS users’ lack of comfort with computers in general rather than on OTIS.

3.2.7. Adding a medication to a patient’s record

Nurses generally had no trouble entering a medication, but noted a few ways in which they felt the process should be improved:

- Allow appropriate resolution for dosage. The drug we asked them to add to the patient’s record, Ambien, is often prescribed as “at night / as needed,” yet OTIS forces the user to choose one or the other. This results in OTIS containing incomplete or inaccurate information.
- Generic drugs. Users reported that they liked that OTIS recognizes the relationship between generics and brand name drugs, but felt that this could be improved by consistently forcing users to enter drugs in either generic or prescription. This is not a usability concern per se, but at least one user felt it would help with communicating to patients what medications they should be on.

3.2.8. OTIS-wide observations

By designing our usability test to cover many areas of OTIS, we are also able to make some general observations and recommendations in addition to noting specific concerns.

- **Vertical scrolling.** On longer pages in OTIS, such as the medications page or viewer, users had to scroll quite a bit to locate information and then back to the navigation buttons or headings at the top of the page. This is consistent with findings from our heuristic evaluation. These problems could easily be avoided by repeating most-used navigation buttons at the bottom and perhaps middle of longer pages, and by repeating table headers after each screen-full of information.
- **“Oh, I can’t click it here.”** On a few pages, icons and text that otherwise appear as navigation elements appear again as decorative or informative elements of the page. Some users became frustrated because they could not tell how these icons are used on some pages. This can be improved with a clearer visual distinction between when an icon is used as a link and when it is not.
- **Feedback during slow responses.** At least in our demo environment, users received no visual feedback when clicking to navigate to a page (other than the viewer) that took some time to load. In some cases, this meant that users were unsure if they had clicked in the right place and subsequently clicked two or three times while waiting, which served only to further increase load times. Increasing feedback
- **Consider increasing visibility of the current patient.** At least one user neglected to change patients between tasks. We are unsure of how often this error happens in practice (vs. in our test environment), but even one occurrence could potentially cause serious problems.
- **Entries for the same data should point to the same data in memory.** We consistently found that information about members of the caregiving team could be accessed through multiple pathways but that each pathway could yield a different result. This should be fixed to prevent inconsistency.
- **Ensure OTIS implements the appropriate resolution.** Sometimes the nurses wanted to enter more information than OTIS allowed, such as the specific time or reason the dosage of a patient’s medication changed or a medication schedule that involves both “at night” and “as needed.”

3.3. Aesthetics

Studies have demonstrated that perceived attractiveness of an interface is one of the most highly correlated factors of a user's satisfaction.¹ In the hospital environment, however, an electronic medical record (EMR) system commands a different set of priorities for determining satisfaction. In interviews with a UHMS nephrologist and an OTIS business analyst, efficiency and accuracy of an EMR system were mentioned as more valuable than the visual attractiveness of the interface. According to them, the foremost aim of an EMR system is to ensure that patient safety and efficient workflow practices are supported.

Although, we did not focus exclusively on aesthetics in any of our usability test questions, we asked open-ended questions in the exit interview to determine what the nurses liked and did not like about OTIS. All nurses did say that they liked using OTIS, but no one pinpointed aesthetic reasons. For example, participant 82 commented, "I really like it [OTIS] because everything is there."

While we cannot speculate that their satisfaction was specifically correlated with the aesthetics of the system, we can draw from previous interviews done for persona development in which interviewees did mention that the look and feel of OTIS was comparatively superior to that of CareWeb. In addition, we observed that the aesthetics did not hamper any of the participants from completing their usability test tasks. Based on this, we determined that the current aesthetics of OTIS does not pose difficulties for the usability of the system.

4. Summary

Our task design methods helped us uncover usability and functionality issues within OTIS. To draft the tasks, we identified situations that clinicians encounter when seeking information from a record by consulting interview notes and researching patient kidney transplant guides on the web. We were then able to write a scenario-based task and then request lab and medication data from Dr. Silas Norman that made sense given the patient's symptoms. We achieved some level of realism despite the limitations of only being able to edit certain data within OTIS demo records. The post-operative nurses we recruited confirmed this by saying that most tasks were consistent with the way that they used OTIS.

The main issue that OTIS users face that all the participants cited was its lack of CareWeb integration. Switching between CareWeb and OTIS to search for information, as well as maintaining duplicate information in both systems is a challenge. During certain tasks in the usability tests, participants stated that they would at that point switch to CareWeb to lookup the patient's appointment history because OTIS did not have the information they needed. Members of the OTIS rewrite committee mentioned that OTIS-CareWeb integration was something that is already on their wish list.

OTIS's functionality has proved to be useful and, for the most part, efficient to use. Participants were able to methodically complete many of the basic tasks that we asked of them. These tasks

¹Lavie, T., Tractinsky, N., 2004. Assessing dimensions of perceived visual aesthetics of web sites. *International Journal of Human-Computer Studies* 60 (3), 269-298.

included adding a medication, searching for a patient, and checking for medications' side effects. Other tasks had multiple pathways to the desired result, sometimes leading to conflicting information. Identifying all diagnoses proved a difficult task because it required the participants to read multiple notes, and if they missed any one note with crucial information, they could not reach a complete answer (one participant did comment that the probability of being placed in such a situation is low).

Identifying the care coordinator was another task that led participants to out-of-date information based on the method that they chose to find the information. Therefore, this functionality needs to be modified to direct users to the most accurate, up-to-date information. We recommend an update of the data model to include a field that reflects the rotation of post-operative care coordinators.

The Medications feature provided participants with information that was not always specific enough to be able to answer the question. For example, when asked when a dosage was changed, all participants went straight to the Medications section and stated when a dose was last prescribed. However, they had to refer to the notes section or even CareWeb's appointment history to determine when a patient reported that they stopped taking a drug. Scrolling through notes to find a particular note is generally inefficient, even though the participants reported being used to doing this. While medication history was available in the viewer and changed doses were flagged with a yellow triangle, some participants did not use these features to find the information. Perhaps the reason for the yellow triangle was never explained or the viewer's slow load time deterred them. In the former case, a tool-tip could explain the meaning of the yellow flag.

We also determined that OTIS could benefit from the general usability observations that we made. Vertical scrolling encumbered some users from locating the information they needed from a page quickly, particularly for the Viewer, but also for the Medications. Well-located pagination buttons/links and repeated headers could solve this issue. Clickable icons in the timeline could also prevent the user from clicking many times on an icon only to discover that the link below it is the only active link. In addition, the current basic patient information should be prominent enough to ensure that users know which patient's information they are working with: one test participant did not switch patients between tasks and began answering Task 2 questions with information from the Task 1 record even though she verbally she kept mentioning the name on the intended patient record. Finally, OTIS could support an optional higher level of detail in some situations. For example, a nurse may want to specify the reason a dose was changed or provide two answers for how a dose should be administered.

Generally, we found the current aesthetics of OTIS to be satisfactory and a non-issue with regards to its impact on the efficiency and effectiveness of the system.

Our usability test revealed ways in which OTIS could help clinical staff find accurate information they need from a patient record. While we are aware that many of the tasks that we designed tested the nurses' procedural knowledge of what they already do on a regular basis, we did uncover some usability issues that OTIS developers could address.

5. Appendix A – Task Scripts

Subject #: _____
Date: _____
Time: _____

OTIS Task 1

Assume that today is March 16, 2007. You are a transplant nurse who will be monitoring a patient named Ricardo Nunez, whose transplant was done somewhere else and is relatively new to the University of Michigan Health System. The patient has scheduled his second clinic visit. He reports that he had a transplant six weeks ago and has a fever. Please use the patient record to find out the following information:

- 1) Who referred this patient to UMHS Transplant center?
- 2) Where was the transplant done?
- 3) Does this physician still follow up with the patient's care? _____
- 4) Do any of the medications that this patient is taking potentially cause the side effect of fever?
- 5) Please talk aloud as you complete this task.

Find the information you need in the patient record to say whether the patient is at risk for rejection or infection. (Please note that the viewer is not fully up to date).

Circle answer: Yes No

- a. If yes, what are your criteria for your analysis?
- b. If no, write out the steps you would take to seek out more information to resolve the issue. If any of these steps involve using OTIS, please talk aloud while using the system.

Subject #: _____
Date: _____
Time: _____

OTIS Task 2

Please answer these questions about Charlotte Aster's patient record:

- 1) What was Aster's diagnosis that necessitated a kidney transplant?
- 2) When did Charlotte Aster last take Prednisone?
- 3) You notice that Aster's last visit should include a prescription for Ambien but does not. Please add the medication to her last visit at the dosage level of 10 mg.
- 4) For her current visit, you want to increase the level of Lipitor to 15 mg. Please do so in OTIS.
- 5) Is Aster taking medication for all of her diagnoses?
- 6) Who is Aster's care coordinator?
- 7) You have found out that Lee Rosenblum has just been assigned as Aster's social worker. Add him in the social worker role in her record as of today.
- 8) When did Aster's dialysis end?
- 9) Which drugs have been changed in the last few visits?
- 10) Which kidney was transplanted (left or right)?

B.2. Post-Test Questionnaire

Subject #: _____

Date: _____

Time: _____

Post-Task 1 Questionnaire

1. Are these tasks consistent with how you use OTIS? How?
2. What, if any features, of OTIS were vague or confusing to you?
3. How does using OTIS feel to you? Does it feel like the most efficient process?
 - a. (If not) What would you change?
 - b. (If yes) Why is that?
4. Are there people who you think would have trouble using OTIS? _____
 - a. (if so) What sorts of people, and what problems would they have?
5. Is there anything else you would like to tell us today?
6. Are these tasks consistent with how you use OTIS? How?
7. What, if any features, of OTIS were vague or confusing to you?
8. How does using OTIS feel to you? Does it feel like the most efficient process?
 - a. (If not) What would you change?
 - b. (If yes) Why is that?
9. Are there people who you think would have trouble using OTIS? _____
 - a. (if so) What sorts of people, and what problems would they have?
10. Is there anything else you would like to tell us today?

7. Appendix C – Introductory Script

[INTRODUCE YOURSELF].

Thank you for agreeing to participate in our study. We are evaluating the usability of the electronic medical record systems used by the University of Michigan Health System, such as CareWeb and OTIS.

Today we will be asking you to complete a few tasks in OTIS. Our goal is to learn more about in what ways OTIS works well and in what ways it could be improved. Our tasks are designed around areas where we expect that we might see usability problems, so please do not feel bad if you run into any problems completing a task.

I will introduce each task and can answer limited clarifying questions, but will otherwise refrain from answering questions. We want you to complete the task as though we are not here. To help us evaluate the system, we ask that you speak aloud what you are doing and thinking as you complete the task.

We will also be recording the screen and you during the test, and you may see me taking notes. This is to help us capture the details of your interaction with OTIS. When you are finished with the tasks, we will move on to a short follow up interview that will help us understand your interactions with OTIS and will help us get your valuable insight.

If at any time during this evaluation you feel uncomfortable, you can stop the test at any time or ask to move on to another task.

[DESCRIBE TASK ONE]

Please start when you are ready, and please remember to talk us through what you are doing and thinking. It might be a little awkward to do so at first, but it helps us out a bunch.

[PROCEED THROUGH OTHER TASKS]

[FOLLOW UP INTERVIEW]

[Thank / provide contact information]

Reset the patient record for Charlotte Aster:

- 1) Under Evaluation/Evaluation Team, leave the social worker assigned person blank (was Lee Rosenblum)
- 2) Delete Ambien from the Medications list.
- 3) Change Lipitor back to 10mg (most recent date).

8. Appendix D – Project Information Sheet and Informed Consent Forms

Subject #: _____
Date: _____
Time: _____

Statement of Informed Consent

We are Rupa Patel, David Hutchful, Ayse Buyuktur, Cheng-Lun Li, and Sean Munson. We are a group of graduate students at the University of Michigan’s School of Information. As part of a course on the evaluation of systems and services, we are conducting studies to assess the effectiveness of OTIS, CareWeb, and other electronic medical record systems.

If you volunteer to participate in this study, you will be asked to use one or more computer systems to complete example tasks and to answer some questions. The questions will be asked orally before, during, and after sample tasks. There also may be written questionnaires before and after each activity. Your interactions with the computer may be recorded on video, audio and/or with still photographs and written notes will be made.

We will compensate you with a \$20 gift certificate for your participation. This may also be an educational experience in how these systems work and you may also enjoy learning about how designers work. We hope that the research will benefit society by improving future versions of OTIS and electronic medical record systems. We do not anticipate that there will be any risks or discomforts to you as a participant in this project. Please do not disclose any information that you feel would put you at risk. We hope this will be a fun and interesting process for you.

All of the information from your session will be kept confidential and be referred to by an ID number. The correspondence between your name and ID number will be kept confidential and treated with the same care as our own confidential information. The results of our work will be presented on a public web site. We will not name you if and when we discuss your behavior on that web site or in research publications. After the research is completed, we may save the notes for future use by ourselves or others. However, this same confidentiality guarantees given here will apply to future storage and use of the materials.

Your participation in this research is voluntary, and you are free to refuse to participate or quit the experiment at any time. Whether or not you chose to participate will have no bearing in relation to your standing at the University of Michigan or the University of Michigan Health System. If you have questions about our research or your participation in it, you may contact us at careverines@umich.edu, or our professor, Dr. Suresh Bhavnani, at (734) 615-8281 or bhavnani@umich.edu.

You may keep a copy of this form for reference.

If you accept these terms, please write your initials and the date here:

Project Information Sheet

1 April 2007

We are Rupa Patel, David Hutchful, Ayse Buyuktur, Cheng-Lun Li, and Sean Munson. We are a group of graduate students at the University of Michigan's School of Information. As part of a course on the evaluation of systems and services, we are conducting studies to assess the effectiveness of OTIS, Careweb, and other electronic medical record systems.

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You may keep a copy of this form for reference.

Subject #: _____
Date: _____
Time: _____

OTIS System Evaluation

As part of our evaluation of OTIS and other electronic medical record systems, we are making a photographic, audio and/or video recording of the operations you perform with one or more interfaces to computer systems and taking notes on what we observe. We would like you to indicate below what uses of these records you are willing to consent to. This is completely up to you. We will only use the records in ways that you agree to. In any use of these records, your name will not be identified.

Please initial all those statements that you agree to. If you wish, you may modify the statements below to better express your wishes; please initial next to any changes you make as well as at the end of each statement to which you agree.

The records can be studied by the research team for use in research reports. _____

The records can be shown to subjects in other experiments. _____

The records can be used in scientific publications. _____

The records can be shown at meetings of scientists interested in the study of human-computer interaction and interaction design. _____

The records can be shown at meetings of educators interested design, engineering, or innovations in education. _____

The records can be shown in public presentations to nonscientific groups. _____

I have read the description and give my consent for the use of the records as indicated above.

Name (printed): _____

Signature: _____

Date: _____