

SI 622

Evaluation of Systems and Services

Winter 2007



Organ Transplant Information System (OTIS)

Heuristic Evaluation

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1. Introduction

1.1. Overview of OTIS

The Transplant Center utilizes OTIS to evaluate potential transplant patients 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. People in many Transplant Center roles use OTIS (e.g., care coordinators, surgeons, nephrologists, inpatient and outpatient nurses, social workers). Although no one person uses all the add/edit features of OTIS, everyone with an OTIS account has the read security access to all aspects of the patient record.

Our understanding of OTIS was based on an interview with the business analyst overseeing its development and interaction with an OTIS marketing demo with a dummy database. We constructed a list of the features of the patient record system, and included that in Appendix C. Of those, the top-level features of OTIS's patient record application are described below:

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)

*The features that we focused on are starred.

When one logs into OTIS, the staff home page gives the user the option to search for a patient. Once a patient is found and chosen, the record view defaults to the Timeline feature.

1.2. Target Audience

Our target audience includes care coordinators, surgeons, nephrologists, and inpatient and outpatient nurses, social workers.

2. Heuristic Evaluation

2.1. Evaluation Goals

Actual user testing is the ideal way of pinpointing the usability issues in a system. However, it is fairly expensive. The heuristic evaluation is a cheaper and quicker method that enables evaluators to identify some of the major usability problems of the system. Conducting a heuristic evaluation early on also helps narrow down which features of the system to focus on in the usability studies. The goal of this heuristic evaluation was to identify some of the single user and groupware usability problems in OTIS and rate their severity.

The methodology section of this report presents the heuristics and rating scale used, as well as the procedure followed in conducting the evaluation. Next, we present the detailed findings from the single-user and collaborative heuristic evaluation. Finally, a conclusion highlights the major findings and the team's observations and interpretations.

2.2. Methodology

2.2.1. Heuristics and Rating Scale

It is important to consider heuristics that are appropriate for the specific system being evaluated in a heuristic evaluation. Since we believe single-user and groupware features are important for the system to efficiently and effectively perform its intended functions, the team decided to use both types of heuristics. Not only is it essential that the system supports the individual user, but it is also necessary that it promotes and supports the overall collaborative workflow of its diverse target population.

We conducted a literature review to identify lists of heuristics that could be assembled and thereby customized towards evaluating both the single user and collaborative aspects of OTIS. For the single user perspective, the team decided to use a combined list of heuristics by Judy Olson and Jakob Nielsen that were compiled by Mike Elledge and Panayiotis Zaphiris. These heuristics map to the following 10 major categories: consistency, correspondence, error recovery, feedback, help and documentation, user's memory load, menu/command structure, system response time, training, and visual display. Please see Appendix A for the complete list of heuristics used. For the evaluation of the collaborative aspects of the system, a list of groupware heuristics were compiled from multiple sources. Please see Appendix B for the complete list of groupware heuristics used for this evaluation.

The following scale was used to rate the system-based only on the five top-level features chosen for the evaluation- in terms of the selected heuristics:

Severity	Meaning
Good	The system is excellent in this regard.
Low	The issue presents an annoyance but does not hinder task completion.
Medium	Issue causes some difficulty with respect to task completion, yet the user can still complete the task.
High	Issue causes substantial difficulty with completing the task or prevents its completion altogether.

2.2.2. Evaluation

OTIS is a fairly complex system with numerous functionalities. Since it was impossible for us to conduct an exhaustive heuristic evaluation of all of its features within the given timeframe, we decided to focus on five major features based on an initial top-level GTN of the system. These were decided upon according to the research questions of the team, information obtained through previous methods such as user interviews, persona and scenario development, user survey results, and a product comparative evaluation, as well as the interests and questions of OTIS's actual developers at the MCIT. These top-level features include the following: Patient search; Timeline; Demographics; Medications; and DMI.

For the evaluation itself, one of our team members who had not seen an OTIS demo previously was chosen as the actual evaluator who walked through each of the features, commenting out loud as he conducted the evaluation. The team checked for each single user and groupware heuristic on the finalized list of heuristics for this evaluation. Three team members took notes during the evaluation, and one team member closely observed the responses and actions of the evaluator as he conducted the evaluation. The team discussed all heuristic categories, and then compiled notes. The rating for each heuristic was decided in a consensus. The evaluation was conducted from an administrator staff viewpoint.

3. Findings

3.1. Findings of Single-User Heuristic Evaluation

3.1.1. Overview of Findings

We looked at the single-user heuristics from the following categories to see how well they meet the needs of the individual user. In addition to collaborative use of the system, we felt that each individual's needs should also be satisfied in order to ensure adoption of the system. The main goal here was to look at how well the interface addressed the heuristics designed to meet individual user goals.

3.1.2. Detailed Findings

Issue	Severity	Description	Heuristic
1	Low	In all pages, “edit” button is tucked off in the corner and is hard to see. (Figure 1)	S1. The system should provide a consistency of look, format information and notification when the mode changes.
2	Medium	When clicking on the kidney list icon on the Timeline, users are led to a new interface in the same window.	
3	Medium	Users keep closing the browser by mistake because they are not sure when a new window will be opened (no notification about changing mode).	

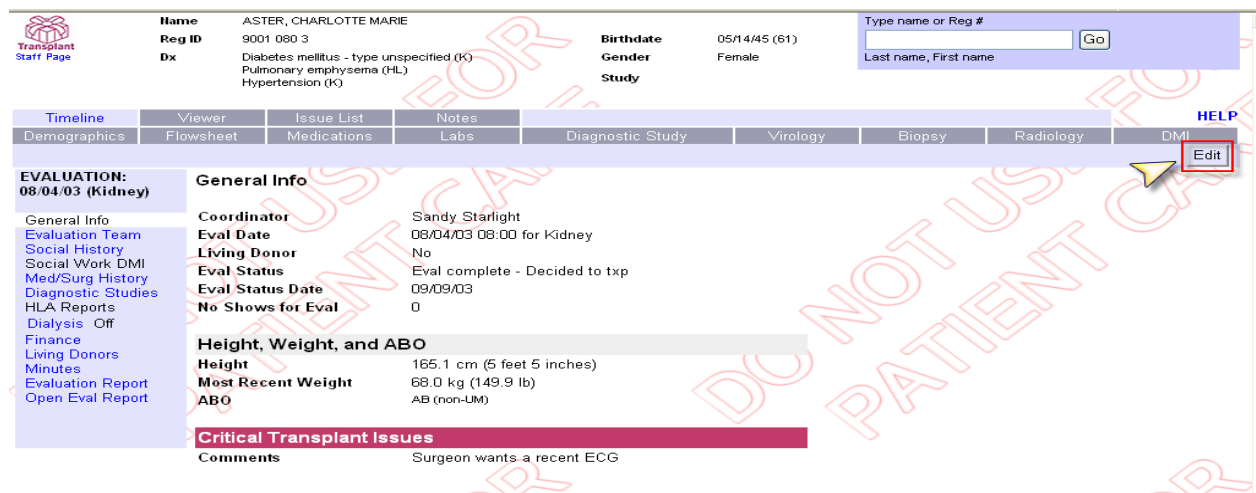


Figure 1. Edit button location consistent but not proximal.

Issue	Severity	Description	Heuristic
4	High	The left navigation menu options sometimes refer to the patient but sometimes refer to the whole system. (Figure 2)	S2. The system should provide information corresponding to the status/ mode the users are in. It

5	Good	The terms/ language used in the system are clear and suitable for users. Using standardized codes for diagnosis may improve efficiency.	should also use the terms that users are familiar with.
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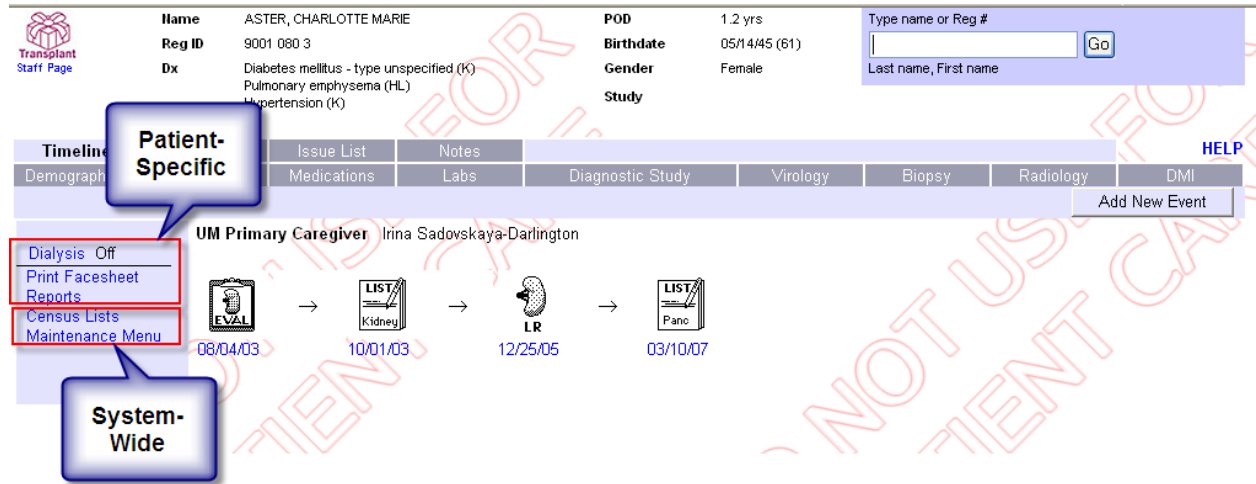


Figure 2. Options are grouped together regardless of whether they are patient-specific or system-wide.

Issue	Severity	Description	Heuristic
6	Good	Error messages occur in appropriate situations (e.g. if a certain drug is on hold for a patient, giving the dosage will lead to an error message (Figure 3))	S3. The system should provide an error presentation mechanism and avoid fatal errors. If an error occurs, the system should be able to provide system recovery options such as an "Undo" option.
7	High	No undo/redo feature in the system. Users intuitively click on the "back" button in the browser window and get an error screen.	
8	High	In the diagnosis edit page, deleting a record is serious enough that it should ask whether you really want to delete or at least have an undo/redo option. However, there is no warning message at all	

One or more drugs have errors; make corrections and click Save again.

Date	03/08/07
TACROLIMUS	<div style="border: 1px solid red; padding: 2px;">Either enter a "Dose" or check the "Hold" box</div> Dose 0 -UNITS- -ROUTES- -FREQ- Hold <input checked="" type="checkbox"/> Special dosage
Myfortic	Dose 320 mg PO BID Hold <input type="checkbox"/> Special dosage
Colace	Dose 100 mg PO BID Hold <input type="checkbox"/> Special dosage

Figure 3. Error message when trying to remove an on hold medicine.

Issue	Severity	Description	Heuristic
9	Good	Error messages occur in appropriate situations (e.g. if a certain drug is on hold for a patient, giving the dosage will lead to an error message (Figure 3))	S4. The system should provide clear feedback on the progress towards the goal that users want to achieve. It should also be able to provide the navigational residue to lead users on the right track.
10	Medium	The system doesn't inform the users of progress. When users go through multiple pages to complete a task, they might lose track of the steps in the process.	
11	Medium	The system doesn't provide links to doctor/ patient information in the medical record.	

Issue	Severity	Description	Heuristic Category
12	Low	Cognitive offloading in the system is well supported thus reducing user's memory load. In some cases, however, identifying a caregiver or referring physician requires some mental work.	S6. The system should minimize the user's memory load.

Overall, OTIS requires very little remembering between tasks. It provides a timeline with icons (Figure 4), which provides a chronological view of major events in a patient's care. The timeline facilitates easy recall and recognition of a patient's status. In some cases, for example in the referring physician search page in the Demographics section (Figure 5), it requires that one know the last name of the referring physician – this could be taxing on a user's memory.

Transplant Staff Page

Name: ASTER, CHARLOTTE MARIE
Reg ID: 9001 080 3
Dx: Diabetes mellitus - type unspecified (K)
Pulmonary emphysema (HL)
Hypertension (K)

POD: 1.2 yrs
Birthdate: 05/14/45 (61)
Gender: Female
Study:

Type name or Reg #
Last name, First name

Timeline | Viewer | Issue List | Notes | [HELP](#)

Demographics | Flowsheet | Medications | Labs | Diagnostic Study | Virology | Biopsy | Radiology | DML

UM Primary Caregiver Irina Sadovskaya-Darlington

Dialysis Off

Print Facesheet
Reports
Census Lists
Maintenance Menu

EVAL → LIST Kidney → LR → LIST Panc

08/04/03 10/01/03 12/25/05 03/10/07

Figure 4. Timeline.

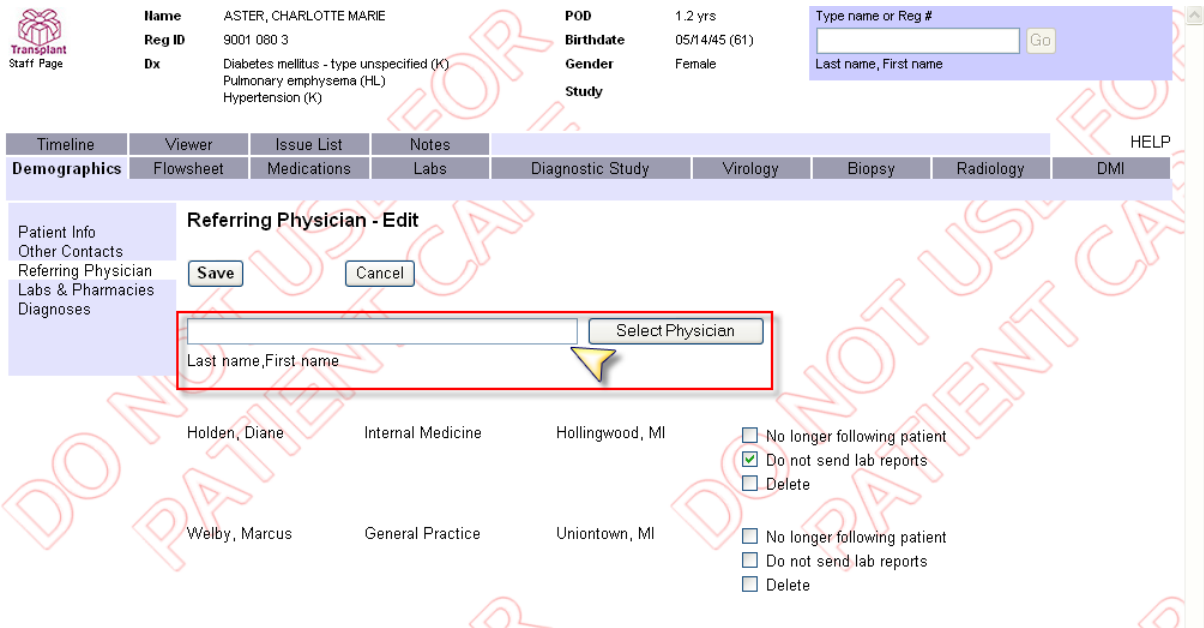



Figure 5. Referring Physician Search.

Issue	Severity	Description	Heuristic Category
13	Good	OTIS provides an intuitive menu/command structure	S7.Menu/Command structure.

The menu/command structure is simple and easy to understand in OTIS. Instructions are clearly marked out, but in some cases exits are not clearly marked (figure 6: tab button to get to timeline). The system does not provide means for shortcuts or simple/advanced user function distinctions; however, from our evaluation this does not seem to be mandatory.

Timeline  HELP OTIS

Listing Information

Name ASTER, CHARLOTTE MARIE	Reg Number 9001 080 3	Organ Kidney
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Listing Status Information

Initial List Date	10/01/03
Coordinator	SMS
Total Days on List	1258
OPO Accession Number	
Functional Status	No activity limitations
Employment Status	Working Part Time Due to Disease

Patient Information

Original Listing Weight	69.9 kg (154.1 lb) 08/04/03
Most Recent Weight	68.0 kg (149.9 lb) 12/25/05
Most Recent Height	165 cm (5 feet 5 inches)
Body Mass Index	24.9

Status History

Date	Status Change	Reason
12/25/05	Reactivated	for fun

Figure 6. Back Button obscurity in the Listing Information Page

Issue	Severity	Description	Heuristic Category
14	Good	OTIS responded in a timely fashion through out test	S8. System Response Time

We experienced no time delays during our evaluations. Our evaluations, however, were done using a laptop running a local copy of the application server. Due to regulation restrictions we could not run our tests in a typical use environment, but we note here that this could be an issue in the larger medical setting, and should be tested when possible.

Issue	Severity	Description	Heuristic Category
15	Good	Minimal training required to use the system.	S9. Training
16	Good	Error Messages	S10. Visual Display
17	Low	Familiarity – generally good, although at times may pose difficulties for new users as it requires too much familiarity.	
18	Low	Proximity of buttons and navigational elements tend to be either too close of far apart	

OTIS presents an effective minimalistic visual display. The timeline feature uses icons that are easy to follow and understand (Figure 4: timeline). Error messages are fairly descriptive and close to the problem area (Figure 3: error for wrong dosage). Readability is good, but the use of whitespace and font sizes could be better implemented since sometimes it's difficult to ascertain if words are headings or not. In addition, blank fields are difficult to identify, due to whitespace (e.g., social worker clearance page).

3.2. Findings of Collaborative Heuristic Evaluation

3.2.1. Overview of Findings

OTIS and other EMR systems are multi-user record keeping systems. The records created in these systems form boundary objects between the variety of caregivers involved in the patient's treatment. In this collaboration, OTIS falls within the realm of computer supported cooperative work (CSCW). Baker, Greenberg, and Gutwin propose an additional set of heuristics for shared workspace heuristics (2002).

3.2.2 Detailed Findings

Issue	Severity	Description	Heuristic
1	Low	The system sometimes makes collaborators visible, but not reliably.	C1. The system should facilitate finding collaborators and finding contact.
2	Low	Authorship of documents is sometimes suppressed.	C4. The system should provide consequential communication of shared artifacts.

3	High	OTIS provides information about other members of the team but does little to indicate anyone's responsibilities within a record or to alert a user to another's presence.	C6. The system should provide awareness information that helps people maintain a sense of shared place and that keeps them informed about shared activity.
4	Low	A last modified date on sections such as demographics may help users know if they are working with current information.	C8. The system should provide protection of shared artifacts.

OTIS provides information about other members of the caregiving team in the evaluation view, authorship information for the DMI notes imported from CareWeb, and displays the primary physician on many pages. This information is not, however, displayed in all areas where the content is created through a caregiver's actions and so users must navigate back to the overview of the caregiving team in order to locate this information. Similarly, many documents do not have their editors' or author's name attached. This makes them seem less like communication and more like available resources, which decreases the meaningfulness of the communication.

We also recommend investigating the addition of presence or "last modified by" information to the OTIS system. While we acknowledge potential disadvantages such as information overload or pollution, finding appropriate ways to build this into OTIS may help provide users with some context about when other users are accessing this system.

Issue	Severity	Description	Heuristic
5	High	When the system provides visibility of current and potential collaborators, it does not provide contact information.	C1. The system should facilitate finding collaborators and finding contact.
6			C2. The system should provide means for intentional and appropriate verbal communication.

In evaluation and other views, the user can see the other members of the caregiving team. The system provides only a name, though, and so users must rely on another system to identify the contact information. This can add substantial additional time and steps to the process of contacting a collaborator and it is not possible to complete this task using only resources provided by OTIS.

We recommend integrating OTIS with UMOD for UMHS personnel and allowing the inclusion of third parties' contact information within the system.

Issue	Severity	Description	Heuristic
7	Good	OTIS is arranged with the pieces of EMR as boundary objects. This is a very effective organization style.	C4. The system should provide consequential communication of shared artifacts.
8	Medium	OTIS eschews explicit communication in favor of object-sharing. It does not support both fully.	C10. The system should allow people to coordinate their actions via explicit communication and the way objects are shared.
9	Area for future development	OTIS does not directly address communication but instead allows it to be a side effect of record keeping.	C2. The system should provide means for intentional and appropriate verbal communication.
10			C3. The system should provide means for intentional and appropriate gestural communication.

OTIS handles explicit communication better than other forms. Even here, though, the communication is handled not as messages between users but as records that become boundary objects. Consequently we do not rate the system on these heuristics but wish to discuss them as a growth potential for OTIS.

We feel that this is appropriate when the paradigm for electronic medical record systems is that they are databases to which multiple users have access and can edit. Our previous literature review suggests that EMR systems are moving towards becoming full-featured collaborative work environments in which patient records are just the primary facet. Continued growth of the communication features in OTIS should be mindful of the cooperative heuristics dealing with communication.

C3, the heuristic regarding gestural and non-explicit communication is a canonical problem in the field of electronic medical records. There are many anecdotal stories of caregivers losing their ability to make quick assessments of a patient's condition based on the appearance (handwriting, weight, etc) of a physical flow sheet when the record keeping transition to a more sterile electronic system. Finding ways to bring back these subtle forms of communication in electronic systems is a major growth opportunity for OTIS and other EMRs.

Issue	Severity	Description	Heuristic
11	High	There is no way to review, at a glance, what has changed since your last visit to a patient's record.	C5. The system should alert the participants of incoming transmissions (files or messages).
12	High	There is no way to direct another caregiver's attention to a particular aspect of a patient's record.	

Another side effect of OTIS treating records as just records is that there is no inbox system like one might find in CareWeb. Because messaging is not part of the application, OTIS users have no way of alerting others or being alerted to incoming transmissions. The Issue List does attempt to serve as a general inbox for the Transplant Center, but its effectiveness is diminished by the sheer volume of tagged issues.

While we find that the system does not comply with these heuristics, we are less convinced that this is a fault in the system. More interview data would help us learn if caregivers need pointers to changed information or if it is best to not overwhelm them with information and to instead expect them to notice relevant information when reviewing a patient's record.

Issue	Severity	Description	Heuristic
13	Medium	Caregiver's roles are not represented in a way that adds context.	C7. To establish a shared context, the system should display people, artifacts and resources in relation to the central purpose of the communication.
14	High	OTIS better supports loosely coupled collaboration. During tightly-coupled work (eg, surgery), users switch to another system (e.g. Centricity) that is not integrated.	C9. The system should manage the transitions between tightly and loosely-coupled collaboration.

15	Good	OTIS's timeline view provides a good overview of the process that indicates where tightly-coupled events fall with respect to the entire, loosely-coupled process.	
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OTIS does communicate caregivers' roles for each patient, but it does so in a way that only sometimes provides context. A consequence is that OTIS provides marginal support for the transition between tightly coupled and loosely coupled collaboration. In the timeline view, a caregiver can quickly see in which phase the patient is – this is an excellent feature. If the patient is in one of the loosely coupled phases, the EMR serves as a central resource while they progress towards the transplant or through the post-op process, and each team member's work gets added to the record and is available to other members of the team. During the tightly coupled phase of the transplant process (the actual surgery), OTIS is not used and Centricity is favored at this point.

We do not disagree with the transition from OTIS to another system for the tightly coupled phases: this is likely better than attempting to use the same system in too many contexts. A recommended potential direction for OTIS is to better integrate with the other system so that the transition between the different forms of collaboration is more seamless and the records may be more complete.

Issue	Severity	Description	Heuristic
16	Good	Documents are protected and there is an audit trail.	C8. The system should provide protection of shared artifacts.
17	Medium	There is no undo feature.	
18	Medium	Previous versions of a document are not accessible.	

4. Summary

Our evaluation revealed that OTIS's interface passed most single-user heuristics, including clear feedback, low memory load for users, a decent visual display, and general error handling. Compared to our previous study of CareWeb's interface, we found OTIS more consistent across features and behavior. Both seem to require minimal training. Navigation could be improved by allowing a clearer path to previously visited pages.

Turning to collaborative heuristics, we find some problems. Many of these problems stem from OTIS's paradigm of using the electronic medical records as boundary objects. In doing so, OTIS presents problems with several shared workspace heuristics particularly as they relate to communication. While we note some of these as problems, we see them not as flaws in the design of OTIS but as an indicator of its growth.

As use of OTIS and other EMR systems becomes more prevalent, the systems have evolved from serving as a central database and into a form of shared workspace. Future efforts to improve OTIS may be optimally spent adding communication features appropriate for this use as a shared workspace. This will involve finding ways to allow users to communicate explicitly and gesturally, as well as adding a deeper sense of presence and context to the system.

5. References

1. Baker, K., Greenberg, S., & Gutwin, C. (2002). Empirical development of a heuristic evaluation methodology for shared workspace groupware. In Proceedings of CSCW 2002. Pp. 96-105.
2. Kirigin, A., Klein, G., & Adelman, L. (2005). Heuristic Evaluation Techniques for Collaborative Software. MITRE Corporation.
3. Nilesen's Heuristics for User Interface Design
4. Nielsen, Jakob & Molich, Rolf. (1990). Heuristic Evaluation of User Interfaces. CHI '90 Proceedings (Seattle, WA, April), pp. 249-256.

6. Appendix A – Single-User Heuristics

Usability Checklist: Mike Elledge and Panayiotis Zaphiris

Number	Characteristic	Measure
1	Consistency	Actions (O) Back-up (O) Format (O) Obvious Action Available (W-2a) Obvious Goal Revision (W-6a)
2	Correspondence	Action Corresponds to User Goal (W-2b) Natural Order for Tasks (O) New Terms Metaphorical & Concrete (O) Simple & Natural Dialogue (N) User Terms/User's Language (O/N) User's Goal Described (W-1)
3	Error Recovery	Avoid Modes (N) Clear & Instructive (O)/Good Error

		Messages (N) Double Check Critical Operations (O) “Undo” Capability (O)
4	Feedback	Clear Progress Toward Goal (W-5a) Needed Information Provided (W-5b) Obvious Task Completion (6b) Response Time (N) System Failure (N)
5	Help and Documentation	Documentation Accessible (O) Documentation Explained (O) Help Accessible Everywhere (O) Help and Documentation Provided (N) Help Context Sensitive (O)
6	Memory Load	Minimize User Load (N)
7	Menu/Command Structure	Clear Instructions Provided (O) Clearly Marked Exists (N) Frequently Used Commands Accessible (O) Other Actions Less Appropriate (W-3) Problem-Free Execution (W-4a) Related Commands Grouped Together (O) Short Cuts (N) Simple/Advanced Options (O) Verb/Object/Modifier Sequence (O)
8	System Response Time	Computed Response (2sec) (O) Keystroke/Mouse (100msec) (O) Time Alerts (O)/Response Time (N)
9	Training	Training for Typical Tasks (O)
10	Visual Display	Error Messages (O) Familiarity (O) Less is More (N) Proximity (O) Readability (O) Screen Areas (O) Similarity (O)

KEY

O = Appears on J. Olson Checklist

N = Appears on J. Nielsen Usability Heuristics list

W = Appears on Walk-through Evaluation list (paraphrased; question # shown for reference)

7. Appendix B – Collaborative Heuristics

1. The system should facilitate finding collaborators and establishing contact.
2. The system should provide means for intentional and appropriate verbal communication.
3. The system should provide means for intentional and appropriate gestural communication.
4. The system should provide consequential communication of shared artifacts.
5. The system should alert the participants of incoming transmissions.
6. The system should provide awareness information that helps people maintain a sense of shared place and that keeps them informed about shared activity. This information includes one person's awareness of others, the artifacts, where things are located, and how things are changing.
7. To establish a shared context, the system should display people, artifacts and resources in relation to the central purpose of the communication. This view should evolve along with the people, the artifacts, and the purposes (of their communication) that define them.
8. The system should provide protection of shared artifacts.
9. The system should manage the transitions between tightly and loosely-coupled collaboration.
10. The system should allow people to coordinate their actions via explicit communication and the way objects are shared.
11. The system should support group process of selecting among alternatives.

8. APPENDIX C – Top Level System Feature Overview

OTIS Top Level Features

START

 Patient Search (by name)

PATIENT RECORD FEATURES

Timeline – default view

 Primary caregiver name (not clickable)

 Dialysis History? (ON/OFF currently)

 Print FaceSheet

 Reports

 OTIS Maintenance Menu

 Census Lists

Event icons with clickable date

Evaluation

- General Info (default view)
- Evaluation Team
- Social History
- Social Work DMI
- Med/Surg. History
- Diagnostics Studies
- HLA Reports
- Dialysis History* (ON/OFF currently)
- Finance
- Living Donors
- Minutes
- Evaluation Report
- Open Eval Report

Donor List

- Listing Information
- Funny-looking button back to timeline

Kidney Transplant

- Recipient Operative Information
- Recipient OR Info
- Donor OR Info

See Labs screen link

Others?

Viewer

- Toggle – Hide all sections or individual sections
- Previous 5, Next 5 dates in history
- Per date, Review link
- Review Visit, checkbox
- Save
- Cancel

Where are all the back buttons?

Clinical Events – Mammogram

History for Mammogram – 1 available

Clinical events – Pap Smear

History for Pap Smear - none

Clinical events – Colonoscopy

History for Colonoscopy - none

Clinical events – Bone density

History for Bone density - none

Issue List

Kidney Program Issue List - none

Radio button, checked by default - Go to program Issue List (already here though)

Radio button, Go to Personal Issue List

Notes

Broken link (!!)

Demographics (if you go into add/edit, can't go choose one level up even though text is there – not good)

Patient Info

Edit

Other Contacts

Edit

Save

Cancel

Add New

Save

Cancel

Referring Physician

Select physician

Save

Cancel

Checkbox – no longer following patient

Checkbox – do not send lab reports

Checkbox – delete

Labs & Pharmacies

Edit / Add

Save

Cancel

Change Lab

Cancel and Go Back

Checkbox - Delete Lab

Select Alternate Lab

Cancel and Go Back

Change Pharmacy