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Usability of a Drug-Drug Interaction Inquiry System for Kidney Transplant Patients

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Abstract:

Background and objectives:

Kidney transplant recipients are at increased risk for adverse safety events related to reduced renal function and polypharmacy. Health information technology (HIT) tools have a precautionary role in improving safety in patients with kidney transplants who are at risk of drug-drug interactions.

Design, participants and measurements:

Usability testing of a Drug-Drug Interaction Inquiry System on a representative sample of kidney transplant patients and their family members was conducted between January-April 2013, by a single interviewer. Each participant was provided with 35 tasks to complete on a mobile phone with a manual key pad. The tasks were classified according to how it was completed: easily completed / non-critical error, or critical error (where a participant was unable to complete the given task without intervention by the interviewer). The final task was timed using a stop watch.

Results:

Out of a total of 16 volunteers, 15 completed the testing. The median time to complete the final task was 4 minutes (range 2-9 minutes). In a cumulative total of 525 tasks, 33 critical errors were noted. Twelve participants had greater than or equal to one critical error.

Most frequent critical errors were related to typing and spelling words. Twelve out fifteen participants were able to complete the final task without any critical errors.

Conclusions:

Understanding transplant patients preference in technology use and adapting applications to a variety of technological portals will ensure the most effective use of targeted interventions in patient safety, particularly when applied to preventing drug-drug interactions.

Introduction:

Drug–drug interactions (DDIs) have been identified as a significant public health problem in the US as well as around the world. According to published estimates, nearly 200,000 hospitalizations in USA annually are related to DDIs (1).

Patients with chronic kidney disease and end stage renal disease who receive a kidney transplant are introduced post-transplant to effective, but potentially toxic immunosuppressive agents with a narrow therapeutic index. In addition, as with many other drugs, immunosuppressants are metabolized through the P-glycoprotein and cytochrome P450 (CYP) enzyme systems in the liver. Monitoring of therapeutic immunosuppressant levels is part of routine post-transplant care to reduce the occurrence of drug toxicity. Due to pre-existing conditions which lead to chronic kidney disease, such as hypertension and diabetes, as well as newly occurring conditions such as opportunistic infections, kidney transplant patients are taking a combination of several drugs, potentially leading to serious DDIs (2) Therefore, these patients are at increased risk of adverse events due to their reduced renal function and polypharmacy related to their post-transplant status and co-existing conditions.

In addition to regular monitoring of immunosuppressant drug levels, and educating patients to be aware of medication side effects, it is important to find new ways to further improve patient safety when they are on multi-drug regimens. This is particularly important when new drugs are introduced to the patient's lists of daily medications. For example, during an acute illness an emergency care provider at a center unfamiliar with

the patient's condition could add a new antibiotic which could substantially interact with other medications.

Despite the on-going efforts of transplant centers in offering assistance to newly transplanted patients with advice on taking medications, patient feedback suggests that many kidney transplant recipients struggle with getting used to taking multiple new medications added to their routine daily list of drugs.

To improve their chances of improved health outcomes, post-transplant patients and their caregivers need improved opportunities to learn self-management of their condition(s), including self- monitoring of symptoms, and knowledge about the risks and benefits of the use of medications (3).

In this usability testing pilot study, we focus on how well a representative sample of kidney transplant recipients can use a precautionary Drug-Drug Interaction Inquiry System (DIIS) targeted at reducing the risk of undesirable interactions between immunosuppressant medications and a sampling of other therapeutic agents.

Materials and Methods:

The test materials including the electronic application used in this present study were adapted from the applications used in the Safe Kidney Care™ cohort study (clinicaltrials.gov NCT 01407367) at the University of Maryland School of Medicine (4,5). All study documents were based on guidelines from U.S. Department of Health and Human Services' (HHS) (6).

Usability testing of this novel transplant directed - DIIS application was performed using a mobile device with SMS texting. A third party SMS Gateway service (Twilio™ www.twilio.com) was used to develop the SMS application. The purpose of the Gateway service is to allow the receipt, routing and response to text messages sent by the user. Inbound SMS can be received and processed from any of the major telecommunications services in the US. Once the message is received, the text is routed to a central server with a web interface which hosts the administrative website. This website features is able to track the inbound and outbound messages. This application was developed to be accessible with any standard cellular telephone or an android cellular telephone. For purposes of this study, we used a standard cellular telephone with a push button (manual typing) key board. The main feature available to the SMS texting users was the ability to send text messages with the names of a transplant medication and another medication of interest, to find out if there was potential for interaction between the two drugs. The user would receive a response text message stating one of the following, depending on their choice of drugs: “CAUTION! Speak to your healthcare provider”, “NOT SAFE in transplant patients!!”, or “SAFE in transplant patients”.

Study participants and testing:

We conducted usability testing on a (convenient) sample of kidney transplant patients attending an outpatient transplant clinic during January 2013- April 2013.

This study was approved as an exempt protocol according to Title 45, Code of Federal regulations part 46 by the Institutional review Board of the University of Maryland at Baltimore. A convenience sample of fifteen (15) patients, and one family member attending the University of Maryland transplant clinic underwent beta testing on how to improve the DIIS System, using a study cell phone which we provided. A single interviewer administered the testing and recorded the findings.

We pre-tested the system on three staff members who gave us feedback on the drafted task list. Based on this feedback, modifications were made to some of the tasks such as eliminating the need to switch between letters and numbers on the cell phone key-pad which required extra time.

Testing process:

Each participant filled out a questionnaire with their demographics, educational level and previous experience using devices such as cell phone, texting and smartphones.

Each participant was taken to a quiet private room in the clinic area where the basic features of the study cellphone, including the shift key, space key, center select key and the clear/back key were demonstrated. The phone number for texting and messages

was provided on a series of cards in easily readable font size to be used as reference while participants attempted to complete each task once they were satisfied with the basics of the study cell phone; each participant was given 35 sequential tasks to complete (Appendix 1).

After the initial task list (tasks 1-8, Appendix 1) which were intended to familiarize the participants on use of the study cell phone to access the SMS texting service, we gave three scenarios (Task 13, 24 and 25) where participants were asked to use the texting system to find out if a new drug that was prescribed to a hypothetical patient would be safe to use with a transplant medication they were already taking.

Each task was rated as 1.) Critical error/problem severity high: prevents the user from completing the task (score=0), 2.) Non-critical error/problem severity moderate: causes user difficulty but task can be completed or problem severity low: minor problems that do not significantly affect the task completion (score=1), or 3. problem severity none: User completed task without difficulty; task completed (score=2).

The final task was timed using a stop watch. An exit questionnaire/Posttest Interview was conducted to document user impression of the system; additionally, participants were asked to list two things they would like to be changed to improve the system. The Exit/User impression questionnaire is in Appendix 2.

Statistical considerations:

Descriptive statistics are presented, consistent with the reporting of qualitative results of usability testing. No hypothesis testing was done in this study. Binomial and qualitative variables are presented as n (%). Critical and non-critical error frequencies for each subject are presented, followed by the error frequency for two groups of users: one group consisting of those using text-messaging daily, and the other, of those who used texting less than daily, or never.

Results:

Participant demographics are shown in Table 1: Over half of participants were over 50 years old. Out of the 14 participants who disclosed their annual income range, four (4) earned less than $20,000. All participants were familiar with using a standard cell phone device and twelve (12) used SMS-texting daily. The majority (n=9) of participants were familiar with using a personal android/smart phone daily. Two (2) participants who used cell phones to speak on the phone stated that they had never texted before, but were willing to try the beta testing of the study cell phone.

Table 2 lists the accomplishment of tasks by the rate of errors, and the frequency of routine use of text messaging among the participants. Results from one participant who completed only 23 out of the 35 tasks were excluded from this table. (Due to not having her reading glasses and inability to read the cell phone screen display). Each participant completed 35 tasks; A total of 525 usability tasks were performed by 15 participants, with a total of 33 critical errors (6.3%). Although there were more critical

errors among those who used text messaging less than daily or never (13.3%) compared to those who were used to texting daily (4.5%), both groups were able to complete over 60% of tasks easily: 285 of 420 tasks completed easily (67.9%) among those texting daily, compared to 66 out of 105 tasks completed easily (62.9%) among those texting less than daily or never. Table 2 shows task performance by each participant. There were five participants, all used to texting daily, who completed the task list with no critical errors. No participant was able to complete all tasks without any type of error (critical or non-critical).

The two most common critical errors were related to spelling of some key words: 40% of participants could not type the word “Transplant” correctly using the phone’s keypad, after the tester showed a reference card with the word typed on it. Participants (40%) made critical errors typing the word “Erythromycin “on the phone keyboard despite being shown a reference card with the typed word. The next set of three errors were each noted in 20% of participants, and consisted of critical errors when 1) pressing the dash button on the phone key pad, 2) reading the entire text message by scrolling down using the toggle button, and 3) In attempting to complete the final task: “Send a message to the KT-SMS Service and find out if the drug Amlodipine is safe to use with the transplant drug Mycophenolate, and the tester showed participants a card with all the relevant steps. This final task was timed by the observer using a stop watch, and the median completion time was 4 minutes.

The results of the user impressions questionnaire are given in Table 5. Over 80% (n=13) agreed that the system would help in avoiding the use of potentially harmful medications, and over 70% (n=12) agreed that they liked to use the SMS texting system for this purpose.

Discussion:

In this report, we describe for the first time, our efforts to develop a SMS texting strategy for cell phones which might potentially aid patients in reducing the risk for DDIs. Although standard tools such as paper handouts with medication lists, pill boxes, and telephone advice services have been used for many years, in this era of advancing communication technology, it is important to explore how patients and their providers can improve upon these old strategies to minimize adverse outcomes related to medication errors. Previous research suggests that patients with chronic kidney disease, especially those with low income and educational level, should be targeted for preventive measures to reduce long-term disability (7). Despite the proliferation of mobile communication devices in the United States, little is known about how the kidney transplant patient population, a diverse group in terms of age, health literacy, and socioeconomic status, are able to use this technology.

Usability testing is a process that attempts to incorporate feedback from a sample of the target population of users of an electronic intervention (8). It is a testing method that is

used to ensure that the intended users of a system can complete a required set of tasks in an efficient, effective and satisfactory way (9).

In previously published studies, electronic Medication Inquiry System (MIS) usability testing was conducted on non-dialysis dependent patients with chronic kidney disease via several platforms including Short Message Texting (SMS). Although participants showed overall satisfaction with using the MIS via texting to find information about potentially harmful medications, there was a wide range of competency among participants in using electronic devices (4,5). Our literature review indicated that studies targeting kidney transplant patients regarding the use of technology for self-management of their chronic health condition were limited in size and number (10).

A recently published study focused on patients' attitudes towards health-monitoring of their kidney transplant status using mobile devices, including a mobile phone, particularly for medication adherence (10). This questionnaire-based study demonstrated that kidney transplant patients overall had a positive attitude towards using mobile phone messaging for health monitoring, including feeling that this technology would be an opportunity for self-efficacy (10). Despite the growth of cell phone use among the US population (11), no studies have so far been published regarding the use of these devices in the precautionary management of potential DDIs in kidney transplant patients.

Due to the rapid proliferation of health information technology, government agencies, academics, as well as health care providers are increasingly focusing on broadening their own research interests, guidelines and practices to include health care delivery through technological applications (12-17).

As part of this trend, instruments such as mobile phones and other portable devices are increasingly used in all aspects of health care delivery, including in the management of chronic conditions, with overall positive results (18,19). However, a report by the Institute of Medicine in 2004 on health literacy reported that over half of the adult US population had trouble obtaining, processing, as well as understanding health information that they needed to make health-related decisions (20). This attention to patient sensibilities regarding the use of information technology is important if they are to be given more autonomy in the management of complex chronic conditions using patient-centered devices (21).

The results of our study indicate that, this representative sample of users varied in age, income and educational levels, as well as in their familiarity with text-messaging. The majority of participants responded positively regarding the ease of use of the text messaging service.

Despite this high level of overall satisfaction with the system, participants had varied level of competency in navigating the steps involved in sending and receiving text messages *i.e.*, the perceived confidence in ability to use the device did not always

translate into correct usage, which has been shown in other studies where perceived technical skills overestimate measured technical skills (22). The common critical errors involved spelling errors as well as technical problems with pressing the correct tabs and buttons in the device itself. One of the common responses from the participants to the question as to how to improve the system reflected the issue of spelling, with many citing this as a problem. With the advent of smart phones with integrated spelling and easy to use icons or apps, we anticipate that some of the difficulties related to correctly typing names of drugs on a key board, as well as the multiple steps involved in standard key board texting would become redundant. However, in addition to incorporating usability testing feedback into the design of electronic applications, we believe that it is essential to give clear "how to use" instructions through orientation sessions, and step by step instruction cards, before patients are expected to successfully use such devices at home.

This study is limited due to the descriptive and qualitative nature, and we were not able to conduct formal hypothesis testing, with a small sample size. However, our sample size (n=16), is adequate for usability testing purposes, where five to eight testers are considered to be sufficient (23). Furthermore, the current study was limited to the use of a standard cell phone text messaging system. Since early 2012, the percentage of American adults using Smart phones has increased, and the percentage of ownership of other cell phones has decreased (24). This is a reflection of the recent transition by all major telecommunication providers, mainly towards smart phones and other mobile, hand held devices with World Wide Web access features. In keeping with this trend, we

propose future studies where usability testing is conducted on multiple IT platforms targeting the kidney transplant population.

Understanding kidney transplant patients' preference in technology use and adapting applications to a variety of technology portals will ensure the most effective use of targeted interventions to improve patient safety. Technology-based applications have the potential to provide precautionary guidance on the avoidance of DDIs and improve overall safety in a kidney transplant population. We believe that these novel devices will help address the issue of DDIs, with a view to minimizing the risk of medication related nephrotoxicity as well as hospital admissions for other systemic symptoms possibly related to polypharmacy.

Table 1

Participant Demographics (n=16)

	All
Characteristic	N (%)
Age	
<30	3 (19)
30-49	3 (19)
50-64	9 (56)
≥ 65	1(6)
Sex	
Male	9 (56)
Race/Ethnicity	
Non-Hispanic White	7 (44)
Non-Hispanic Black	8 (50)
Other, Non-Hispanic	1 (6)
Household Income	
<$20,000	4 (25)
$20,000-$50,000	4 (25)
$50,000-$100,00	3 (19)
>$100,000	3 (19)
Did not wish to answer	2 (12)
Education	
<High School	3 (19)
High School	2 (12)
Some College	5 (31)
College	3 (19)
Tech/Vocational	2 (12)
Grad/Professional	1 (6)
Sends/Receives SMS	
Daily	12 (75)
Never	2(12)
6 days or less per week	2 (12)

Table 2

Task performance by each participant

Participant	Age	Experience with texting	Critical Errors (%)	Non-Critical Errors (%)	Easily completed (%)	Time to complete final task[a] (minutes)	Comments
1	50-64	Daily	2 (5.7)	6 (17.1)	27 (77.1)	3	
2	50-64	Daily	0 (0.0)	2 (5.7)	33 (94.3)	2	
3	50-64	Never	7 (20.0)	8 (22.9)	20 (57.1)	6	
4	50-64	Occasionally [b]	5 (14.3)	14(40.0)	16 (45.7)	9	
5	18-29	Daily	2(5.7)	2(5.7)	31(88.6)	4	
6	50-64	Never [c]	7(30.4)	8(34.8)	8(34.8)	incomplete	Completed 23 out of 35 tasks
7	50-64	Occasionally	2(5.7)	3(8.6)	30(85.7)	5	
8	50-64	Daily	0 (0.0)	4(11.4)	31(88.6)	5	
9	50-64	Daily	0(0.0)	7(20.0)	28(80.0)	3	
10	65+	Daily	0(0.0)	15(42.9)	20(57.1)	5	
11	30-49	Daily	1(2.9)	13(37.1)	21(60.0)	3	
12	18-29	Daily	0(0.0)	12(34.2)	23(65.7)	2	
13	30-49	Daily	5(14.3)	21(60.0)	9(25.7)	4	
14	18-29	Daily	4(11.4%)	13(37.1)	18(51.4)	4	
15	30-49	Daily	3(8.6%)	16(45.7)	16(45.7)	5	
16	50-64	Daily	2(5.7)	5 (14.3)	28 (80.0)	4	

[a] Time to complete task is the time to complete scenario *#3, Appendix 1 task 31*

[b] Participant speaks English as second language; not fluent in English.

[c] Participant did not complete tasks; stopped at scenario *#1 Appendix 1 task 23* (difficulty seeing texting keys and messages due to poor near vision)

Table 3

Categories of task completion.

Task accomplishment [a]	All tasks [b] (n=15)	Frequency of Text messaging	
		Daily (n=12)	Less than daily or never(n=03)
Total tasks	525	420	105
Critical errors	33 (6.3%)	19(4.5%)	14 (13.3%)
Non critical errors	141(26.9%)	116(27.6%)	25(23.8%)
Easily completed	351(66.9%)	285(67.9%)	66(62.9%)

[a] Participant #6 (completed 23 out of 35 tasks) was excluded from this table.

[b]Thirty five tasks were completed by each participant.

Table 4

List of the most common critical errors made by participants:

Description of Critical Error	Participants [a] (%) (n=15)	Comment
Type in the word 'TRANSPLANT' using the phone's keypad. *[Tester shows card with the word "TRANSPLANT"]*	6 (40)	Spelling error. Unable to correctly key in the full word.
After you receive a message from the KT-SMS Service, reply back with the drug name 'Erythromycin' *[Tester shows participant card with message: "DrugB space ERYTHORMYCIN"]*	6 (40)	Spelling error, or problems with spacing.
Go to the Messaging Center by pressing the dash button on the upper left corner of the keypad.	3 (20)	Pressing wrong button.
Read the entire message to me	3 (20)	Did not read the entire message by pressing toggle button to scroll down.
Send a text message to the KT-SMS Service and Find out if the drug Amlodipine is safe to use with the transplant drug Mycophenolate. [Tester shows participant a card with all relevant steps].	3 (20)	This is the final Task in the test.

[a] Participant #6 (completed 23 out of 35 tasks) was excluded from this table.

Table 5

Participant testimonials:

Question/Impression					
Text messaging service is easy to use [a]	Very Easy *(n=3 18.8%)*	Easy (*n*=7 *43.8%)*	Somewhat Easy (n=3 *18.8%)*	Neutral (n=2 12.5%)	Difficult (n=1 6.3%)
Easy to find out if drugs are safe to use together using this service [b]	Strongly agree (n=4 25%)	Agree (n=6 37.5%)	Somewhat Agree (n=4 *25%)*		Disagree (n=2 12.5%)
The system would help in avoiding the use of potentially harmful medications with transplant medication [c]	Strongly agree (n=8 50%)	Agree (n=5 31.3%)	Somewhat Agree (n=2 12.5*%)*		Disagree (n=1 6.3%)
Like to use the text messaging system to find out potential drug interactions. [d]	Strongly agree (n=7 43.8%)	Agree (n=5 31.3%)	Somewhat Agree (n=2 12.5*%)*		Disagree (n=2 12.5%)
How to improve the system [e]	"Use (transplant) medication names patients are familiar with, e.g., "Prograf" rather than "Tacrolimus). "Use a letter code for each drug rather than the long drug name" "Instead of the text message "Transplant", shorten it to "TX" (easier to spell) "find an easier way to spell medication names; concern about copying medication names from pill bottles (small letters and maybe problems spelling)". "Spelling the medication name is difficult but I think the full name of the medicine needs to be entered to avoid confusion (mistake) with other drugs with similar sounding names". "Shorten drug names. Have a list of drugs with abbreviations (codes) come up; e.g., ERYTRHOMYCIN=ERY" "Picking from a list rather than typing". "Drop down menu for patient to select from a list of drugs and press ok" "Put over the counter medicines also in the system. Find a way to (check for interactions), all the drugs patient on with a new drug" "Lot of typing; reduce steps, one text instead of several steps" "Voice prompts-put on speaker" (for people with difficulty typing/reading". "Letters in the phone too small"				

[a] How easy or difficult did you find the KT-SMS text message service to use?

[b] It is easy to find out if drugs are safe to use together using the KT-SMS/text service

[c] I think the system will help me avoid using medicines that may be harmful to use with my transplant medication.

[d] I like using the cell phone text messaging system to find out whether a medication may react with my transplant medicine; [e] Can you list two things you would like to see changed to make the system better?

Appendix 1: Task List*

Task	Task description
1	"Open the cell phone."
2	"Show me where you see the word 'message'."
3	"Go to the Messaging Center by pressing the dash button on the upper left corner of the keypad."
4	"Show me on the screen where it says, 'New Message.'"
5	"Now, press the 'OK' button on the key pad to select 'New Message' so you can create a message."
6	"Press the 'OK' button on the key pad to select the 'TXT Message' option."
7	"Using the keypad, enter the telephone number for the KT-SMS Service *[SHOW CARD WITH NUMBER]* "The number is xxx-xxx-xxxx Let me know when you Have finished typing in the number"
8	"Go ahead and press the 'OK' button on the keypad."
9	"Type in the word 'TRANSPLANT' using the phone's keypad. *[SHOW PARTICIPANT CARD WITH "TRANSPLANT"]* Let me know when you have finished typing in the word 'TRANSPLANT'
10	"Now, send the message by pressing the 'OK' button on the keypad."
11	"View the received text message now by pressing the 'OK' button on the keypad."
12	Task: "Read the entire message to me"
13	*[READ SCENARIO #1]: You have an infection on your toe, and the urgent care doctor has prescribed "Erythromycin"; you want to know if this medicine is safe for you to take with the anti-rejection drug Tacrolimus .You will use the KT-SMS Service to find out.* " Open the phone and select the 'Message' option so you can go to the messaging center".
14	"Now, select 'New Message' and then 'TXT Message' so you can create a new text message."
15	: "Using the phone key pad, type in the KT-SMS Service telephone number and then press the 'OK' button when you are finished. The number is xxx-xxx-xxxx *[SHOW PARTICIPANT CARD WITH PHONE NUMBER]*
16	"Type in the word 'Transplant' using the phone's keypad and press the 'OK' button to send your message." *[SHOW PARTICIPANT CARD WITH "Transplant"]*

*During pre- beta testing on a small group of volunteers, we noted that switching between letters and numbers on the cellphone key pad was time consuming and difficult. Therefore, the task message was changed to all letters, for example, "Drug 1 (space) a was changed to "Drug A (space) a" (Tasks 19, 30 &35)

Appendix 1 Task List continued…

Task	Task description
17	"View the received text message now by pressing the 'OK'button on the keypad and then read the entire message using the toggle button."
18	"Press 'OK' on the key pad to go to the REPLY option and then press 'OK' again to select TXT Message."
19	"Using the phone's key pad, type in the letter for the drug "Tacrolimus", the message is DrugA space a Let me know when you are finished." *[SHOW PARTICIPANT CARD WITH DrugA space a]*
20	"Press the 'OK' button to send your message. Let me know when you think you have received a message back. "
21	"View your message and read to me what it says."
22	"After you receive a message from the KT-SMS Service, reply back with the drug name 'Erythromycin'" *SHOW PARTICIPANT CARD WITH "DrugB space ERYTHORMYCIN" [MESSAGE]*
23	"When you receive a message back, read the message and tell me what you think that it means".

[READ SCENARIO #2 "A new doctor at your primary care clinic has given you a prescription for acid reflux; the name of the drug is pantoprazole. You want to know if this medicine is safe for you to take with the anti-rejection drug Mycophenolate. You will use the KT-SMS Service to find out".

24	Open the phone and select the 'Message' option so you can go to the messaging center.
25	"Now, select 'New Message' and then 'TXT Message' so you can create a new text message."
26	"Using the phone key pad, type in the KT-SMS Service telephone number and then press the 'OK' button when you are finished. The number is xxx-xxx-xxxx*[SHOW PARTICIPANT CARD WITH PHONE NUMBER*]
27	"Type in the word 'transplant' using the phone's keypad and press the 'OK' button to send your message." *[SHOW PARTICIPANT CARD WITH "transplant"]*
28	"View the received text message now by pressing the 'OK' button on the keypad and then read the entire message using the toggle button."
29	"Press 'OK' on the key pad to go to the REPLY options and then press 'OK' again to select TXT Message."

Appendix 1 Task List continued…

Task	Task description
30	"Using the phone's key pad, type in the letter for the drug "Mycophenolate, the message is Drug A space d" Let me know when you are finished." *[SHOW PARTICIPANT CARD WITH DRUG NAME and letter: "DrugA space d"]*
31	"Press the 'OK' button to send your message. Let me know when you think you have received a message back.
32	"View your message and read to me what it says."
33	"After you receive a message from the KT-SMS Service, reply back with the drug name 'Pantoprazole'" *SHOW PARTICIPANT CARD WITH "DrugB PANTOPRAZOLE" [MESSAGE]*
34	"When you receive a message back, read the message and tell me what you think that it means".
35	*[READ SCENARIO #3]: "You have been prescribed a new medicine, "amlodipine" for high blood pressure, by your doctor,and you want to know if this medicine is safe for you to take with the anti-rejection drug Mycophenolate. You will use the KT-SMS Service to find out".* Task: "Send a text message to the KT-SMS Service and tell me if this drug Amlodipine is safe to use with Mycophenolate". [SHOW PARTICIPANT CARD WITH PHONE NUMBER, "transplant" , THE TRANSPLANT DRUG NAME AND letter, Mycophenolate, "d", and the SECOND DRUG: "Amlodipine".

Appendix 3: EXIT QUESTIONS/USER IMPRESSIONS QUESTIONNAIRE:

1. How easy or difficult did you find the KT-SMS text message service to use?

- ☐ Very difficult
- ☐ Difficult
- ☐ Somewhat difficult
- ☐ Neutral (don't know)
- ☐ Somewhat easy
- ☐ Easy
- ☐ Very easy

How much do you agree or disagree with the following statements?

2. It is easy to find out if drugs are safe to use together using the KT-SMS/text service

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

3. I think this system will help me avoid using medicines that may be harmful to use with my transplant medication.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

4. I like using the cell phone text message system to find out whether a medication may react with my transplant medicine.

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

5. Can you list two things that you would like to see changed to make the system better?

Figure Legend

Figure 1. Usability Testing and Acceptance of a Drug-drug Interaction Inquiry system for Kidney Transplant Recipients

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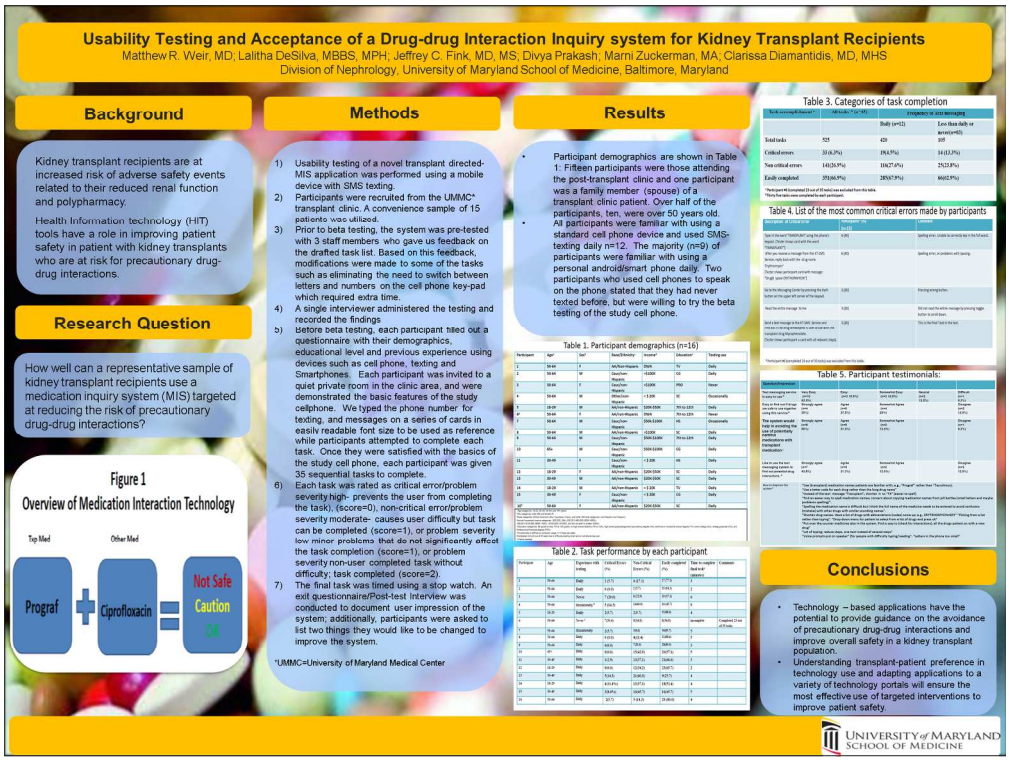

Figure 1
609x457mm (96 x 96 DPI)