DIMA: Designing Assistive Technologies for Dialysis Patients

Katie A. Siek*
Computer Science
Indiana University
Bloomington, Indiana
ksiek@cs.indiana.edu

ABSTRACT

DIMA (Dietary Intake Monitoring Application) is a proof-of-concept personal digital assistant application for dialysis patients to monitor their fluid and sodium intake. Dialysis patients can only consume 1 liter of fluid and two grams of sodium each day. Patients who do not comply with their dietary restrictions run the risk of hypertension, pulmonary edema, and death. Currently, patients try to remember or write down in a food diary their fluid and sodium consumption. However, these techniques are insufficient because 80% of patients are unable to restrict their fluid intake. My dissertation focuses on designing a framework for usability studies in non-traditional environments, integrating technology into chronically ill populations who do not ordinarily use technology, and designing an interface for people with low literacy skills.

INTRODUCTION

Think about everything you ate today. How much fluid did you drink? Remember to include your morning cup of coffee, soda at lunch, sip from the water fountain, and the ice cream from dessert. How much sodium did you consume? Did you consume more than a liter of fluid (approximately three cans of soda) or a couple grams of sodium (approximately two paper clips) today?

If you think figuring out the answer to these questions are difficult, you are not alone. Dialysis patients all over the world have trouble with these calculations. However unlike you, if a dialysis patient miscalculates their fluid or sodium intake, they run the risk of hypertension, pulmonary edema, and death[1].

*Katie A. Siek is supported in part by a National Physical Science Consortium Fellowship and by a stipend from Sandia National Laboratories/CA. Many thanks to Kay H. Connelly and Yvonne Rogers for their support and guidance.

[1]The amount of fluid and sodium consumption allowed varies among patients

Currently patients keep track of their fluid and sodium intake by remembering or writing/drawing what they eat in a food diary. Welch et al. has shown that these techniques are insufficient since 80% of motivated patients are unable to restrict their fluid intake[7]. Research has shown that 1/3 of dialysis patients have difficulty performing simple calculations [2], let alone more complex calculations such as conversions between units of volume (i.e. fluid ounces to liters).

We are creating a proof-of-concept personal digital assistant (PDA) application called DIMA (Dietary Intake Monitoring Application) for dialysis patients with low literacy skills and limited technology experienced to monitor fluid and sodium intake. Patients can select food icons on the PDA screen or scan food Universal Product Codes (UPCs) to easily input food. Monitoring fluid and sodium levels could help patients monitor their dietary intake and improve their quality of life.

Challenges and Contributions

The biggest challenges associated with developing DIMA are that our user group has low literacy skills and little computer skills. More importantly, we are training and conducting usability studies in a busy dialysis ward during treatments. Our research can contribute to the field of computing by:

- Creating a framework for usability testing in non-traditional environments focusing on discussion techniques [1]
- Building on methods to integrate technology into user groups that do not ordinarily use technology via incremental games
- Designing a simple interface with lots of information (i.e. possible dietary consumption) for people with low literacy skills using iterative design methodology

Originality of Work

While there have been many studies regarding handheld devices in health care, to the best of our knowledge our application will be the first dialysis intervention to use a handheld computer. Previous dialysis interventions have focused on patient counseling or hands-on education in a clinical setting. Our intervention will always be with the patient giving them direct feedback on how their diet effects their fluid and sodium levels.

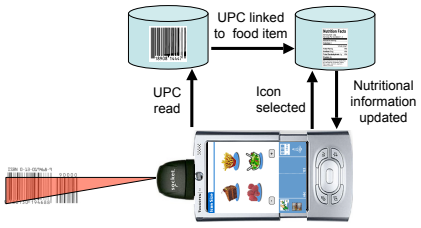

Figure 1. DIMA's backend

There has been a lot of research on conducting usability studies in traditional environments (i.e. laboratory setting) and work has begun on how to conduct usability studies for mobile applications [4]. However, we would argue that usability testing in non-traditional environments (i.e. dialysis wards) has a subset of challenges that require a new framework for usability testing [1].

We will build off the the work done by Grisedale et al. to create a simple interface with lots of information for our user group with low literacy skills [3].

INTERDISCIPLINARY TIES

We are closely working with two nurses, a nephrologist, a dietician, and a biostatician at Indiana University-Purdue University's School of Medicine in Indianapolis, Indiana. Our contacts at IUPUI's School of Medicine will assist us in recruiting and training dialysis patients; ensure DIMA is accurate and can assist clinicians with compliance data; and evaluate the impact our application has on the health of dialysis patients.

THE APPROACH AND PRELIMINARY WORK

We are developing DIMA in four stages. We completed the first two stages and are currently working on the third and fourth stage.

1. **Match users needs to technology.** We decided to use a Socket SDIO In-Hand Scanner and Tungsten T3 based on the requirements we created after interviewing dialysis patients and clinicians.

2. **Initial user study.** We compared how healthy and chronically ill novice PDA users in various age groups could complete tasks (pressing buttons, viewing icons, voice recording,scanning barcodes, etc.). Our study used quantitative (i.e. counting errors) and qualitative (i.e. NASA Task Load Index) metrics to measure usability. We found that there were no major differences in performance among user groups [6].

3. **User interface.** We are iteratively designing the interface with participatory design methods. Patients and clinicians will be involved at every design step. The graphical user interface shows food items and nutritional and fluid intake levels. While designing the interface we will refine the discussion techniques for non-traditional usability testing.

4. **Application backend.** The backend is responsible for connecting a UPC database with a nutritional USDA database and saving information about food items the users consume as shown in Figure 1. We will create small games to help participants become more comfortable with the technology and application to assist with integration of DIMA into their everyday lives.

IMPACT AND IMPORTANCE

The advantages of our application are (1) dietary and fluid intake will be automatically computed; (2) patients will not need to read labels, make mathematical conversions, or do mathematical computations to effectively use the application; (3) accurate diet and fluid intake can be recorded and monitored; (4) ongoing feedback can be provided to help patients make improved decisions about diet or fluid intake on a prospective basis; and (5) patients will not worry about the stigma of disease.

FUTURE WORK

Given sufficient positive feedback, we would like to modify our application to assist people with other chronic illnesses such as diabetes or heart disease. Our system can easily be customized to track any nutritional ingredient available in our USDA database. In addition to expanding our user group, we would like to integrate wireless access into our system to ensure users get quick feedback when a food item is not in the USDA database.

REFERENCES

1. K. Connelly, K.A. Siek, V. Lafond-Favieres, and G. Bennett. Planes, pains, and phosphorane: Usability studies in non-traditional environments. In *Proc. of INTERACT 2005*, 2005.

2. J. Evans, C. Wagner, and J. Welch. Cognitive status in hemodialysis patients. *Renal Failure*, 2004.

3. S. Grisedale, M. Graves, and A. Grunsteidl. Designing a graphical user interface for healthcare workers in rural india. In *SIGCHI 1997*, 1997.

4. J. Scholtz and S. Consolvo. Towards a discipline for evaluating ubiquitous computing applications. Technical report, Intel Research, 2004.

5. R.S. Shapiro, N. Deshetler, and H.E. Stockard. Fluid overload again! a technique to enhance fluid compliance. *Dialysis and Transplantation*, 23(6):303, June 1994.

6. K. Siek, K. Connelly, and Y. Rogers. A comparative study of elderly, younger, and chronically ill novice pda users. Technical report, IU, 2004.

7. J.L. Welch, S. Perkins, J. Evans, and S. Bajpai. Differences in beliefs by stage of fluid adherence. *Journal of Renal Nutrition*, 2003.

SINGLE SENTENCE STATEMENT OF PROBLEM

My research focuses on (1) developing a framework for usability studies in non-traditional environments, (2) integrating technology into groups who do not ordinarily use technology, and (3) designing a simple interface that gives lots of information by creating an application to assist dialysis patients monitor their fluid and sodium intake.

EXPECTATIONS

By participating in the Tapia Doctoral Consortium, I hope to get feedback about my application design and ideas about how to measure success of the new usability framework. I can contribute to the doctoral consortium my knowledge of interdisciplinary research and research in interface design.

1750 North Range Road, C103
Bloomington, IN 47408
ksiek@cs.indiana.edu

May 20, 2005

Sandia National Laboratories/CA
PO Box 969
Livermore, CA 94551
nmberry@sandia.gov

Dear Dr. Nina Berry and Doctoral Consortium Committee,

Please allow me to introduce myself. I am a computer science PhD Candidate at Indiana University - Bloomington. My research focuses on integrating pervasive technologies into communities that do not ordinarily use technology. More specifically, I am interested in designing and developing usable systems for everyday life and usability testing in non-traditional environments.

For the PhD Consortium, I will discuss my dissertation topic - Designing Assistive Technologies for Dialysis Patients. DIMA (Dietary Intake Monitoring Application) is a proof-of-concept personal digital assistant application for dialysis patients to monitor their fluid and sodium intake. Dialysis patients can only consume 1 liter of fluid and two grams of sodium each day. Patients who do not comply with their dietary restrictions run the risk of hypertension, pulmonary edema, and death. Currently, patients try to remember or write down in a food diary their fluid and sodium consumption. However, these techniques are insufficient because 80% of patients are unable to restrict their fluid intake. My dissertation focuses on designing a framework for usability studies in non-traditional environments, integrating technology into chronically ill populations who do not ordinarily use technology, and designing an interface that conveys lots of information for people with low literacy skills.

My proposal date is set for July 13, 2005. The designated area my research falls into is primarily human computer interaction.

Thank you for your time. Please feel free to contact me at the above contact information if you have any questions or concerns.

Sincerely,

Katie A. Siek