

Don't Let Me Down: Using Contextual Information to Aid Diabetics

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ABSTRACT

People who suffer from Diabetes are required to make frequent decisions on their personal treatment based on results from self-care devices. Yet these results form only a part of the decision-making process and surrounding contextual information is a highly important aspect. Those who suffer from diabetes have described the daily challenges of dealing with unexpected results and a feeling of failure at managing the disease. This paper describes ongoing research which focuses on using technology to assist in the capture of the contextual information to both aid the understanding of results and to potentially reduce the emotional impact of perceived bad results.

Author Keywords

Diabetes, home care devices, device design, sense-making, user experience

ACM Classification Keywords

H.5.2 User Interfaces.

General Terms

Design, Experimentation, Human Factors.

INTRODUCTION

Conditions such as diabetes rely on patients taking an active role in the monitoring and treatment of their disease. Diabetics face a constant battle to maintain their glucose levels, as their condition greatly impacts on the body's ability to perform this function. Devices such as glucose monitors form an essential part of this process by allowing patients to check the level of glucose in their blood stream, which in turn, informs future decisions regarding treatment and lifestyle choices.

However there are issues arising from interactions with glucose monitors that complicate the interactions and experiences that patients will encounter. Patients have discussed

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Figure 1. The tools typically used for a glucose reading

the emotional impact of using glucose monitors and the implications bad results can have on their confidence to manage their condition:

- “On the surface, it seems like a very fast task, it takes less than a minute. But when you have to deal with the results and think about it, its a lot more than that.”
- “I went through a phase of only recording what I perceived as good results and wouldnt want to commit the bad ones to paper to be scrutinized by my doctor later! Its the bad ones I most needed to pay attention to and get help from my doctor.”
- “It can be very difficult seeing those readings and feeling that it is a personal judgment of my failure as a diabetic to properly control my blood sugar.”¹

Such negative emotional impact as a result of using devices designed to support is highly undesirable. This is potentially because the results that the monitors provide only form part of the decision process. Additional information such as food consumed and exercise (whether planned or completed) are also involved in the treatment decisions.

Thesis Statement

My thesis aims to resolve whether the addition of on-demand contextual information through a mobile application can improve a patients understanding of their condition. Specifically, improving their knowledge of results to better inform

¹Quotes taken from www.diabetesdaily.com

treatment decisions. This work will primarily look at aiding diabetics and attempt to provide greater interpretation of glucose values, which it is hoped in turn reduce the emotional impact results can have. By using mobile applications to capture information in real-time it is possible that those suffering from diabetes will be able to make more informed immediate decisions, as well as being able to fully appreciate data when reviewing at a later date.

Research Contribution

The proposed thesis will focus on the following key areas:

- 1) A framework to design for self-care patients.** The proposed work will focus on designing tools to benefit self-care patients. Therefore, from the data gathered from discussions with patients an opportunity has arisen to suggest a design framework for devices that are to be used by self-care patients. Such an understanding will inform requirements.
- 2) Investigating benefits of contextual information on emotional impact of results.** As those on diets are disenchanted after a bad weigh-in, so too do diabetics suffer when they believe their glucose is under tight control. Providing the patients with on-demand contextual information may reduce the emotional impact of a bad result. Understanding that a result is high because of certain food choices made previously may turn the disappointment into a learning opportunity.
- 3) Investigating benefits of contextual information on understanding of results.** Diabetics will need to make immediate decisions on their treatment, but they are also required to spot trends in their results. Mamykina et al. [5] put forward the idea of reflective thinking and I aim to build upon this notion. The addition of contextual information such as exercise and food intake may increase a patients understanding of results, and better detect trends in their condition.

RELATED WORK

Depression amongst diabetics is key concern as patients suffering from it have been found to be more likely to give up on self-care sooner [1]. After conducting a study asking patients about their previous week of diabetes self-care, it was found that those likely to suffer from depression spent less time monitoring their blood glucose, less time exercising and were less likely to maintain a healthy diet.

Matthews and Doherty [7] developed a system to assist teenagers suffering from mental health problems to capture their mood and experiences. This data was then to be used during the teenagers regular therapist sessions. It was found during this study that adherence to completing the diary logging was improved when the participants were using a mobile phone as opposed to paper based logging.

Previous work has already been conducted into using mobile phones to support diabetics. Mamykina et al. [6] set out to understand the management practices of diabetics. This work led to the creation of systems which made use of mobile phones to support reflective thinking of results [3, 4, 5].

A key aim here was to make use of mobiles to support diabetics in their daily lives.

Contextual information about glucose results forms an essential part of the management of diabetes. Simply knowing a result is meaningless without knowing the situations that occurred around it. To provide a greater understanding of glucose results, a study [10] that introduced photography as an additional method of recording information was carried out. Patients were asked to take pictures of the food they were eating around the time a test was performed. An interface was then designed which color-coded results (between low, normal and high) and allowed users to match food choices with resulting scores.

Additional work has been conducted using mobile phones to aid diabetics during regular activities. Kanstrup et al. [2] developed Living Laboratory which consists of a database that can provide diabetics with immediate information on topics such as the food a particular restaurant serves.

Preuveneers and Berbers [9] are using mobile phones to capture location and activity to predict future exercise activity and alert patients to the potential impact on glucose results. For example, the system is able to detect that a person will regularly walk to work at a same time every morning and alert the patient that they will need to prepare for the trip by increasing their glucose levels.

Work to develop an iPhone application for diabetics to assist in the process of spotting trends in their glucose results has been conducted by OMurchu and Sigfridsson [8]. They believe that it is the trends that are important to understanding the condition, rather than a list of result. Their future work will focus on integrating social network support and facilitating patientdoctor sessions to allow for more community support to diabetics, and a valued second opinion.

METHODOLOGICAL APPROACH

The approach to resolving answers to my research questions will rely on building prototype systems and conducting user studies to both improve the design and understand the impact a design may be having on the user.

1) A framework to design for self-care patients. In order to gather meaningful and accurate data, discussions will be held with diabetics throughout the course of this thesis. Initially these discussions took the form of questionnaires, however it has since become apparent that this has not provided sufficient useful information. Subsequently the focus has now switched to conducting semi-structured interviews in an attempt to gain further insight into the current interaction experiences of diabetics, as well as building a set of requirements for a future application.

The requirements can then be used to form a foundation for a design framework. This framework will inform the design of the proposed mobile application, allowing for the initial validation of the framework to be conducted.

2) Investigating benefits of contextual information on emotional impact of results. Patients have a very simplistic method of recording results and it often only includes the date, time and glucose result. Therefore a result that may have been acceptable at the time, may be misunderstood while looking back at a logbook. Capturing additional information and storing may enable more sense-making of numbers when reviewing results. Similar methods to those used by Matthews and Doherty [7] to assess the adherence to a mobile diary, as well as capturing mood scores could be included.

3) Investigating benefits of contextual information on understanding of results. In order to assess the proposed research will have an impact on a patients understanding of their results, it seems prudent to conduct a diary study. Participants will be recruited and asked to make use of a system over a given time period and to capture their experience and understanding of results.

ON-GOING AND COMPLETED RESEARCH

Initially my research interests were involved with investigating the design of glucose monitors. Critical evaluations of the devices were carried out with a view to suggesting an approach for designing the meters to meet the needs of patients. This work culminated in presenting a poster at Advanced Technologies and Treatments for Diabetes. After attending the presentations and holding discussions with attendees, I became interested in a different angle, specifically how to provide support to diabetics with contextual information.

To date, this new research has focused on understanding the interaction processes that occur while using glucose monitors. A pilot study has been conducted in which a questionnaire was distributed to patients in the surrounding area. Although the study was only small in size (six participants), several interesting issues were raised.

A recurring theme in the feedback received was the desire for discreet interactions with the glucose monitors so the patients could avoid alerting people around them to their diabetes. This is a highly significant point that has led to a decision to make use of mobile phones as the platform for an application. Mobile phones have become an everyday object, and mostly innocuous to many people. It is hoped that mobiles will facilitate those who desire discreet interactions.

Additionally, the preliminary work discovered that of those involved in the study, only one participant made use of a computer to record results. As seen earlier [7], it was described in a study that adherence to a digital diary study was greater than those who made use of paper based diaries. This suggests that introducing digital methods may encourage regular capturing of information.

Work is currently on-going preparing for semi-structured interviews with diabetics to gain yet further insight into the needs and requirements for successful management and understanding of the condition. Conducting regular discussions with diabetics will form an essential part of the remain-

Work Stream	Duration	Start	End
Interviewing Diabetics	3 months	Jul 2011	Sep 2011
Design Framework	4 months	Jul 2011	Oct 2011
Application Development	3 months	Aug 2011	Oct 2011
Application Deployment	4 months	Nov 2011	Feb 2012
Evaluating Application	3 months	Feb 2012	Apr 2012
Thesis Writing	6 months	Jul 2012	Dec 2012

Table 1. Estimated plan for remaining work.

ing research, primarily for the purpose of data gathering. In order for any future application to be successful in its aim to support diabetics, it is essential that the daily challenges and coping strategies of diabetics is fully understood. It is hoped that for this phase of the research, at least twenty diabetics will be recruited and interviewed.

PLANNED RESEARCH

Discussions with diabetic patients are currently ongoing, and likely to continue throughout much of the research time period. Rather than have multiple diabetics to talk to, it is likely these discussions will only take place with two or three, with many more being involved in later evaluations. A proposed timeline for the remaining work can be seen in Table 1, which illustrates the anticipated duration of each work stream described below.

Design Framework

Based on the information gathered from the interviews described earlier, a design framework for self-care patients will be proposed. Guidelines and considerations to support patients who are maintaining their own condition will be suggested. The framework will then inform the design and development of a mobile application which will aim to answer the research questions described earlier.

Application Development

Work to develop a mobile application is currently in an embryonic stage and is being routinely informed by the ongoing discussions with diabetic patients. The application will aim to capture additional information in an attempt to provide patients with more data to allow for a deeper understanding of glucose results.

Upon completion of the initial system a pilot study to evaluate the application will be undertaken. This initial study will involve recruiting participants into a lab-based study to ensure that the system contains no errors and is suitable for its task. It seems sensible that the participants should be diabetics, as they are the ones who will ultimately use the finalized system. The results of this pilot will aim to refine the design of the application and understand further which features may (and may not) be of use. Suitable changes to the design of the application will be carried out based on the results of the pilot study and this process may be iterated several times.

Application Deployment

Once a final version of the application has been created, a large scale deployment will be implemented. Diabetics will

again be recruited for a three month longitudinal study where they will be asked to make regular use of the application. It is hoped that the application will fit easily into the daily routines of diabetics and be inconspicuous rather than obtrusive. A key design choice in the early stages of this research was to determine a platform that would not place an additional workload on the testing process. Mobile phones were seen as a tool which is already frequently used and unlikely to further single out a diabetic as they are doing something unusual (and to maintain the desire for 'discreet' interactions).

Evaluating Application

The aim of the application is to answer the research questions posed earlier in this document:

1) Investigating benefits of contextual information on emotional impact of results.

2) Investigating benefits of contextual information on understanding of results.

It is essential that good measures to answer these questions are found and the measures are likely to rely heavily on the subjective feedback received from participants of the study. One possible method of measuring the emotional impact of glucose results could involve requesting participants to complete Likert scale answers based on their mood after each blood sugar test. Understanding the application's affect on a patient's understanding of their results has the potential to be extremely difficult. Spotting changes in the glucose trends during the study may yield useful data in this instance.

CONCLUSION

The aim of this project is to provide methods for supporting diabetics with their decision making and understanding of their condition. Research to date has focused on a critical analysis of glucose monitors, before shifting towards investigating the impact that capturing contextual information can have on a patient's sense-making ability. It is planned for a mobile application to be developed and evaluated by a longitudinal study due to take place in the coming months.

ABOUT THE AUTHOR

I began my PhD studies in January 2010, coming from a background in Information Retrieval and Document Triage. The expected completion date is December 2012. My supervision is overseen by Parisa Eslambolchilar (Swansea University) and George Buchanan (City University, London).

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