Understanding Patients' Needs in Diabetes for Mobile Health – A Case Study

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***Abstract*—To understand how to encourage patients to become involved in mobile health (mHealth) development, and to identify their needs that existing mHealth services to not meet, we conducted a case study with diabetes patients. First, we used video analysis or interview to assess the usability of existing apps. Second, we conducted interviews with patients to elicit their clinical needs. We conclude that an mHealth app should provide 1) a function that can inform information about their insulin reaction to specific foods that they have previously eaten, 2) a report in doctor-familiar format to communicate with doctor easily, and 3) reviews of restaurants in SNS format. We developed a blood glucose management software *Glucolight*.**

Keywords-component; Human factors, hypoglycemia, mobile healthcare, intervention, mobile software, food management

I. INTRODUCTION

Mobile health (mHealth) can improve the effectiveness of diabetes self-care. Patients and healthcare providers can easily acquire patient-specific data from a mHealth service, because most patients always carry a mobile phone. Also, patients can make optimal clinical decisions by using analytical results of these data. mHealth applications (apps) also can be used to support diabetes care, but in Korea most patients do not use them, because (1) the user interfaces of existing apps are not easy to use, and (2) mHealth apps usually only record data and provide simple interpretation functions, so patients do not find any value in switching their self-care behavior from using a paper diary to using a mobile. Therefore, to develop successful mHealth apps for patients, we should consider both the design of the interface and the patients' unmet needs. We studied two aspects of mHealth and developed a mobile app *Glucolight*. The user-centered approach has been used to develop mHealth in prior research [1]. Most researchers conducted requirement elicitation study before development, and tested the usability of their app after development. However, we thought that an early-stage study would be superior in both of these stages.

Usually, patients who have experienced abnormal blood glucose (BG) reactions have their own tacit knowledge of BG control. For example, by noting their bodily reaction, patients can remember the amount of insulin that is appropriate to specific meals. However, remembering BG reactions to all foods is a challenging and burdensome task. We also elicited the problem in our user study, and reflected it in our app.

A. Related Work

Most existing mHealth apps do not provide a function that helps patients to record and recall their previous bodily reaction (insulin reaction) to specific foods (Table I). We also reviewed internationally-top-ranked apps like Diabetes Logbook and Fooducate. They also do not serve the searching function. Patients can use Fooducate learn what foods are safe for diabetes because it shows the calorie count and amount of sugar in a food. However, patients want to, and used to eat non-diabetic foods, so diabetes mHealth solutions should consider this real situation and patients' requirements; we identified patients' difficulty to manage foods and BG.

TABLE I. MOBILE APPLICATIONS OF DIABETES SELF-MANAGEMENT

	Name of diabetes management mobile application				
Criterion	***Blood Diary (Korean)***	***Diabetes Manager (Korean)***	***Diabetes Note + (Korean)***	***Blood Glucose Tracker***	***Glucolight***
UI	Calendar	Calendar	List	List	**Calendar**
Input Data	Blood Pressure (BP), BG, weight	BP, BG, insulin, food, exercise, weight	BG, self-check of food and exercise	BP, BG, weight	**BG, insulin, food, exercise**
Searching function	No	No	No	No	**Food based**
Print	No	No	No	No	**At app**

II. METHODS

The study consists of two parts: assessing usability problems of existing apps, and identifying patients' unmet clinical needs.

A. Usability evaluation of exsting mobile applications

We used video analysis or interview to assess the usability of four diabetes-care apps (Table I). The video analysis was conducted for two patients who did not want to meet face-to-face. The video analysis focused on human errors committed when patients used apps. We asked the patients to complete four tasks: record blood glucose level, check prior record, adjust prior record, and view the graph. We asked the patients to verbally describe the purpose of the task, the problems they encountered, and why they had trouble completing the tasks. Another survey was created based on usability checklists developed elsewhere [2]. Ten patients participated in face-to-face interview; we observed their interaction with the apps directly and interviewed them.

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B. Clinical requirements specification

The ten patients who participated in the face-to-face interview also participated the second session of clinical needs specification. We asked patients to describe problems that they encountered in real life when controlling their BG levels.

III. Results

A. Usability Unmet Needs

The patients gave us clear descriptions about the deficiencies of the interface designs. The common criticisms were detected by video analysis and face-to-face interview.

1) Input Interface Streamlining

- Eliminate unnecessary input items: Patients do not want to (or need to) record their weight and blood pressure every day.
- Provide calendar-based input interface: Patients had trouble finding the 'record BG' button on interfaces that were not based on a calendar. They record their conditions every day, so a calendar-based one is suitable.

2) Effective Presentation of Information

- Provide one-day graph: Patients said that 1-week or 1-month graphs are not useful; the average BG of recent 1-week or 1-month might be useful, but the detailed variation over these timescales is unnecessary.
- Facilitate communication with doctors: Patients replied that using apps to communicate with doctors was not easy.

"I should rewrite on a paper diary before visiting doctors."

B. Clinical Unmet Needs

Patients gave clear descriptions on clinical unmet needs of diabetes self-care. Most problems were related to foods.

- Go dining: Patients said that to go dining and to participate in social events are challenging because eating foods prepared by others can be dangerous.
- First trying of new foods: To avoid unpredictable change of BG, patients don't try foods that they haven't eaten since being diagnosed with diabetes.
- Mismatch between food and insulin: Patients all stated that they had experienced hypoglycemia at least once. Hypoglycemia can result from mismatch between food and insulin, or from excessive activity.

"I got hypoglycemia with chocolate cake, because I used twice amount of insulin by assuming that I need more insulin than normal, and it's too much. I got hypoglycemia again with chocolate cake, because I cannot remember the amount of insulin I used before."

IV. Design Considerations and Prototype

We developed a prototype app called *Glucolight*, which has three functions (Fig. 1): (1) A function that can search for patients' insulin reaction to specific foods that they had eaten previously, (2) A report in doctor-familiar format to facilitate communication with their doctor, and (3) Reviews of restaurants in SNS format. Function A helps a patient to find a previous reaction on specific foods to avoid mismatch between food and insulin. BG levels after meals are expressed in traffic lights (Fig. 1. third from left), with the amount of insulin used; if the light of a food is red (hypo- or hyperglycemia), patients should adjust the amount of insulin. Function C helps patients to know other patients' bodily reactions after eating a specific menu in a specific restaurant.

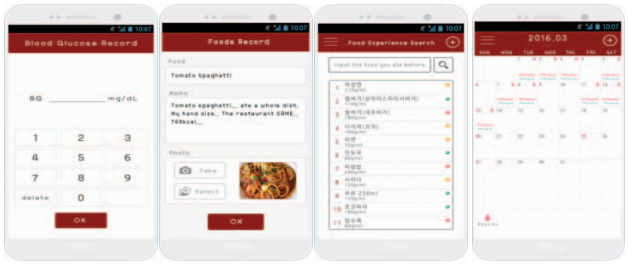

Fig. 1. Prototype. Left, 2nd from left: recording the amount of insulin used, BG level after a meal, and meal; 3rd from left: searching specific foods and insulin reaction experience, right: calendar-based interface

V. Lessons Learned and Summary

Many lessons have been learned during the research. First, we determined that the major two requirements of mHealth services are usability and satisfaction of clinical needs [3]. Some apps had good functions that support patients' care, but because of poor usability, patients did not use these apps. However, good usability design cannot guarantee successful usage. Mobile apps should satisfy clinical needs. Second, patients are initially motivated to use mobile apps due to usual benefits of mobile phone like data storage and portability at first. However, to increase users' motivation to use continuously, additional incentives must be provided. Patients who experience hypoglycemia frequently because of incorrect insulin dose had great interest in our app. To motivate other patients, additional functions may help to increase downloads. We will add some functions like diabetic food recipes and information of the food reactions peer patients experienced.

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