

# A Survey on Ubiquitous Healthcare Service Demand among Diabetic Patients

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**Background:** Advanced information technology can be used when developing diagnostic and treatment strategies to provide better care for diabetic patients. However, the levels of need and demand for the use of technological advances have not been investigated in diabetic patients. We proposed and developed an individualized, ubiquitous (U)-healthcare service using advanced information technology for more effective glucose control. Prior to our service initiation, we surveyed patient needs and other pertinent information.

**Methods:** During August 2009, we conducted a 34-item questionnaire survey among patients with diabetes who were older than 40 years in two certain hospitals in Korea.

**Results:** The mean age of the 228 participants was 61.2±9 years, and males made up 49.1% of the sample. Seventy-one percent replied that they wanted individualized healthcare service, and they also wanted their health information to be delivered through mobile devices such as a cellular phone or a personal digital assistant (40.4%). Most patients had never heard of U-healthcare services (81.1%); however, after explaining the concept, 71.1% of participants responded that they would use the service if it was provided. Despite their willingness, participants were concerned about technical difficulty in using the service (26.3%) as well as the cost of the service (29.8%).

**Conclusion:** The current study suggests that more than 70% of diabetic patients are interested in using U-healthcare services. To encourage widespread use, the application program or device of U-healthcare services should be simple, easy to use and affordable while also including a policy for the protection of private information.

**Keywords:** Blood glucose; Diabetes mellitus; Self-monitoring; U-healthcare system

## INTRODUCTION

The modern era is commonly referred to as an information society or an information age, in which information technology is an integral part of everyday activities and has economical, political and cultural influences. The technological advances in information systems have enabled medical informatics to overcome time and location barriers through the development

of systems that provide real-time, individualized medical treatments that are easily accessible through web-based communication channels [1]. Such advances in medical informatics are also timely, as medical treatment has been shifting focus from disease diagnosis and treatment to health promotion and prevention. This paradigm shift requires wide availability as well as accessibility for both healthcare providers and care recipients. The need for widely available medical information and

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other pertinent health education resources has given rise to the ubiquitous (U)-healthcare concept that has revolutionized the delivery of medical care and healthcare. U-healthcare provides disease prevention, diagnosis and treatment as well as continuous follow-up whenever and wherever they are needed and requested. The innovative application of information technology in medical informatics has been extensively researched because of increasing incidences of chronic diseases that require vast amounts of medical attention and that affect increasing healthcare costs.

Due to an acclimatization to Western lifestyles (including diet), Korea has been experiencing an epidemic of diabetes since the 1980s. Diabetes is now the fourth leading cause of death in Korea, following cancer, cerebrovascular diseases, and cardiovascular diseases.

Diabetes care seeks to improve symptoms of diabetes by preventing acute and chronic complications through glucose control [2]. Proper self-care that includes a healthy lifestyle is essential in diabetes care, but it is difficult for many people to maintain such health practices. Diabetic patients commonly neglect physical exercise and have unhealthy dietary habits which result in poor glycemic control [3].

To address these issues, a new healthcare methodology using a U-healthcare system has been introduced to induce effective glucose control. Low cost and energy-efficient glucometers with mobile systems and a Zigbee communication protocol allow diabetic patients to be more autonomous in the control of their glucose level [4]. This system demonstrated that health education is effective for improving self-care in diabetes management, an effective means of reducing diabetic complications and maintaining a healthy lifestyle [5]. Another study that used health information distribution or consultation through the internet or e-mail showed that 67% of participants were more aware of their health conditions compared to non-users. Some of them were influenced by this system to change their lifestyles and to choose alternative medical services [6]. Therefore, evidence suggests that information technology can relieve some of the difficulties experienced during self-care of glucose control [7].

Previous studies have indicated that active self-monitoring of blood glucose (SMBG) has a substantial effect on the management of diabetes and its complications [8,9]. Recently, the application of an internet-based glucose control system, developed in Korea, showed superior long-term glucose control for patients compared to that of conventional treatment [10]. This

study laid the groundwork for the introduction of a web-based methodology for glucose control. In addition, the combined application of mobile devices and web-based monitoring systems for chronic diseases showed improvements in various metabolic parameters in obese patients with diabetes and hypertension [11].

Therefore, the application of a U-healthcare system based on advanced information technology would be helpful in diabetes management. However, understanding the levels of need and demand among diabetic patients with regard to the use of technological advances is required for this system to be successful. We developed and plan to provide an individualized U-healthcare service using advanced information technology that enables more effective glucose control. Prior to our service initiation, we surveyed patient needs and other pertinent information regarding medical service usage.

## METHODS

### Study participants

This study was a survey conducted in August 2009 in Seoul National University Hospital and Seoul National University Bundang Hospital. The included subjects were diabetic patients who visited one of the two hospitals, who were older than 40 years and who had no mental impairments that could interfere with the survey. The exclusion criteria were illiteracy, mental handicap, inability to communicate, cognitive dysfunction, and lack of consent. The survey was administered to 250 total participants. However, 18 participants did not complete the survey for reasons such as busy schedules, and four participants possessed one or more exclusion criterion. Ultimately, a total of 228 diabetic subjects agreed to the survey: 80 participants from Seoul National University Hospital and 148 participants from Seoul National University Bundang Hospital. The participants were interviewed individually by three interviewers who fully understood the survey questions and who were trained to conduct the interviews. The Seoul National University Bundang Hospital Institutional Review Board approved this study, and all patients gave their written informed consent.

### Method

The survey questionnaires were developed by a healthcare informatics expert and consisted of five categories and 34 questions: general information, current health status, internet usage, health information, and U-healthcare services and related

devices. To obtain accurate responses from every participant, each question was delivered by an interviewer. The survey was performed anonymously: data about age and gender were obtained from personal private information.

The survey consisted of six sections: 1) general information, 2) health information, 3) internet use information, 4) medical service request information, 5) U-healthcare service information, and 6) U-healthcare service technology information. The questions about the most preferred types of information on the health-portal site, most preferred types of services on the health-portal site and functional needs of medical appliances were multiple-choice questions.

The purpose of the survey questionnaires was to identify patient awareness and requests for the U-healthcare service. All of the information gathered from this survey remained confidential and was used for research purposes only. Participant identities remained anonymous and were not disclosed to any unauthorized persons.

The internal consistency for the survey protocol as indicated by Cronbach's alpha was 0.89. All data are presented as means  $\pm$  standard deviation or number (%). All analyses were performed using the SPSS version 12.0 software package (SPSS Inc., Chicago, IL, USA).

## RESULTS

### General characteristics of the survey population

Of the total participants, 49.1% were male and 50.9% were female. The mean age was  $61.2 \pm 9$  years (range, 40 to 85 years) (Table 1). The general characteristics of the study subjects did not differ between the two hospitals. The proportions of participants in their 40s, 50s, 60s, 70s, and over 80 years of age were 13.1%, 28%, 38.6%, 18.3%, and 1.7%, respectively. With regard to the educational levels of the participants, 7.9% had finished from primary school, 13.6% finished junior high school was, 38.2% graduated from high school, 27.6% had college degrees, and 10.5% had completed graduate school. Approximately 29.4% of the study participants lived in metropolitan cities, 65.4% lived in medium-sized cities and 4.4% lived in rural areas.

The current or most recent profession of most of the participants was housewife (32.5%), followed by unemployment (17.5%), self-employment (17.1%), professional (8.3%), office worker (7.0%), civil servant (5.7%), technician (3.5%), farmer (2.6%), and temporary worker (0.9%).

Most participants lived with their spouses (83.3%), though

**Table 1.** General characteristics of the survey participants

Characteristic	
Age, yr	61.2 $\pm$ 9
Sex, M:F	49.1 : 50.9
Education level	
Primary school	18 (7.9)
Junior high school	31 (13.6)
High school	87 (38.2)
University	63 (27.6)
Graduate school	24 (10.5)
No answer	5 (2.2)
Income/mo (Korean Won)	
<1,000,000	38 (16.7)
1,000,000-1,999,000	40 (17.5)
2,000,000-2,999,000	48 (21.1)
3,000,000-4,999,000	46 (20.2)
$\geq$ 5,000,000	53 (23.2)
No answer	3 (1.3)
Comorbidity	
Cardiovascular disease	107 (46.9)
Renal disease	19 (8.3)
Gastrointestinal disease	28 (12.3)
Musculoskeletal disease	35 (15.4)
None	39 (17.1)

Values are presented as mean  $\pm$  standard deviation or number (%).

many lived with their children (46.1%), parents (4.8%), or grandchildren (4.4%). Participants who lived alone comprised 5.3% of our study population.

The monthly average incomes for the participants were categorized as follows: 16.7% made less than 1,000,000 Korean won (KRW; close to 1,000 US dollars), 17.5% earned 1,000,000-1,990,000 KRW, 21.1% netted 2,000,000-2,990,000 KRW, 20.2% brought in 3,000,000-4,990,000 KRW, and 23.2% earned over 5,000,000 KRW. For the monthly expenditures for health and medical services, 11.8% of people paid less than 50,000 KRW, 21.9% spent 50,000-100,000 KRW, 28.9% paid out 100,000-200,000 KRW, 17.1% spent 200,000-300,000 KRW, 6.1% owed 300,000-500,000 KRW, and 12.3% paid 500,000-1,000,000 KRW.

### Health status of the participants

When asked about health status, 19.3% of participants answered that they "feel good and have no problems performing daily

activities,” and 59.2% said “there is something wrong with my health, but I have no problems performing daily activities.” The answer “there is something wrong with my health, and I have some problems performing daily activities” was given by 19.7% of interviewees, and 1.3% of participants replied that “there is something wrong with my health, and I need help from others to perform daily activities.” About 80% of participants reported that they were able to carry out daily activities unassisted.

The most common concomitant illnesses among participants were cardiovascular disease (hypertension/angina/coronary disease; 46.9%), gastrointestinal disease (gastritis/ulcer; 12.35%), kidney disease (8.3%), and musculoskeletal diseases (15.4%).

The most difficult part about managing diabetes at home was reported to be “preparation of healthy meals and diet control” (45.2%), followed by “lack of exercise and having no idea how to exercise” (25.4%). In addition, participants had difficulty taking daily medication and adjusting their doses (10.1%), as well as coping with varying body conditions (10.1%). The answers were not different between sites.

**Pattern of internet usage in participants**

Most (82.0%) survey participants answered that they had personal computers; however, only 39.9% had basic knowledge of computers or internet use, and only 24.6% reported competency with a computer/the internet. The average amount of internet use was seven hours per week.

**Medical service request information**

Interviewees responded that they wanted to receive individualized healthcare information primarily by cell phone or personal digital assistant (PDA) (40.4%), followed by regular mail (25.9%), websites (14.5%), e-mail (13.6%), and internet TV (1.8%) (Fig. 1A).

Regarding the delivery format of medical/health information, 61.4% of participants wanted a “full written explanation.” The second most common answer was “videos with explanation” (17.1%), followed by “voice recording of explanation” (13.6%), and “pictures with simple explanations” (6.6%). Therefore, a number of participants wanted to receive their medical/health information in written format (Fig. 1B).

We found that 71.5% of interviewees were willing to use an internet site that provided individualized medical/health information. When asked “What kind of information would you like to obtain from internet sites that provide individualized medical/health information?,” 78.5% of participants wanted to receive “personal medical information.” The next preferred choices were “personalized diet plan” (51.8%) and “personalized exercise regimen” (46.1%). Additionally, 41.7% wanted information about personalized health recommendations (disease follow-up/prevention education) (Table 2).

Participants also wanted to receive the following services from internet sites that provide individualized medical/health information: hospital appointments for check-ups (57.5%), printout services for current health-monitoring status (46.9%), e-mail communication with an appropriate medical team (29.4%), and internet community services (e.g., forums for specific dis-

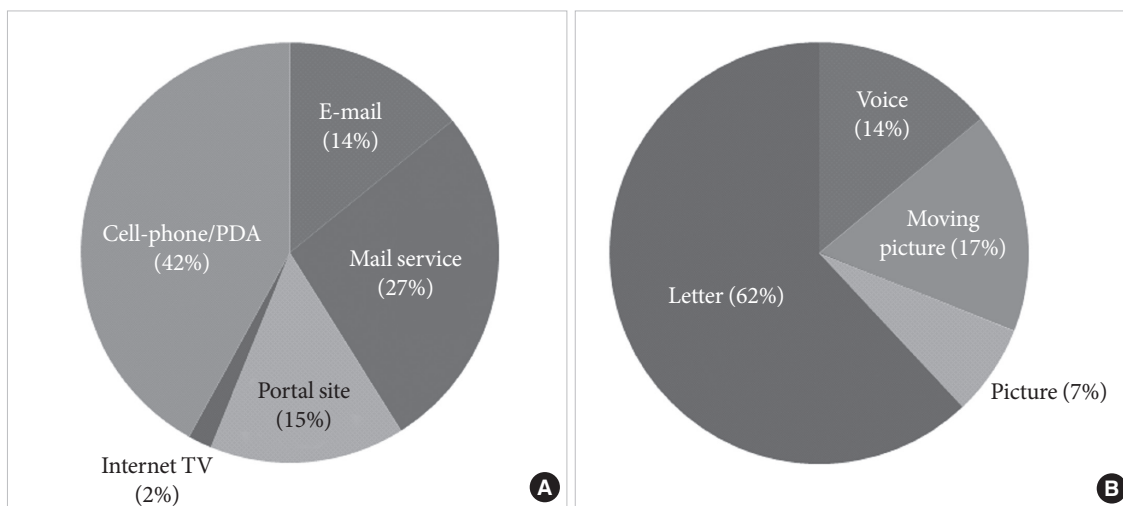


Fig. 1. Delivery method (A) and delivery format of health information (B).

**Table 2.** Most preferred types of information on the health-portal site (multiple choices were allowed)

Item	
Personal medical information	179 (78.5)
Personalized menu or diet	118 (51.8)
Personalized exercise regimen	105 (46.1)
Health news	56 (24.6)
Personalized health recommendations	95 (41.7)

Values are presented as number (%).

**Table 3.** Most preferred types of services on the health-portal site (multiple choices were allowed)

Item	
Hospital appointments for check-ups	131 (57.5)
Printout services for current health status	107 (46.9)
Communication with appropriate medical teams	67 (29.4)
Internet community service	34 (14.9)

Values are presented as number (%).

eases) (14.9%) (Table 3). The answers were not different between sites.

### U-healthcare service information

Surprisingly, 81.1% of participants had not heard of U-healthcare services. After explaining U-healthcare services, the majority reported interest in access to “diabetes management services” by U-healthcare (78.5%), followed by “diet management services” (49.1%), “hypertension management services” (43.4%), and “physical-activity management services” (37.7%).

When asked “How might U-healthcare services benefit you?”, participants answered that they would be able to use these services to monitor their health conditions at home (38.2%). This finding suggests that people are interested in their own health conditions and are seeking ways to better manage them. The subsequent choices were “follow-up of medical conditions at home” (22.0%) and “timely delivery of health information” (11.0%). “diet and physical activity management” and “evaluation of home medical/health conditions by my physician” were also important to participants (Table 4).

In response to the question “What might be some of the difficulties in using U-healthcare services?”, participants selected “cost of service” as their first choice (29.8%). The second choice was “user difficulties in home medical supplies/equipment” (26.3%). The third answer was “infrequent use at home” (22.4%).

**Table 4.** Possible benefits of U-healthcare services

Item	
Ability to monitor health conditions at home	87 (38.2)
Timely delivery of health information	25 (11.0)
Follow-up of medical conditions at home	50 (22.0)
Diet and physical activity management	25 (11.0)
Evaluation of home medical/health conditions by my physician	23 (10.1)
No answer	18 (7.9)

Values are presented as number (%).

The places from which participants wanted to be able to access U-healthcare services were the home (80.7%), office (14.5%), anywhere (10.1%), local health department (4.4%), and fitness center (2.6%).

Most patients (71.1% and 83.8%, respectively) reported that they would rather receive U-healthcare services at their home instead of having to go to the hospital and that they would take advantage of the services if they were available. Therefore, most participants were receptive to the U-healthcare services that would be provided by the hospital.

In responding to the reasonable monthly cost for the U-healthcare service, 84.2% of participants answered that 30,000-50,000 KRW was most reasonable (84.2%). Only 8.8% chose 50,000-70,000 KRW. The answers were not different between sites.

### U-healthcare service technology information

At the time of the survey, 74.6% of interviewees were using home medical supplies/equipments such as glucose or blood pressure monitors. Out of these users, “pain involved with measuring” was reported to be the most difficult task associated with this use (14.9%). “Difficulty in preparing the devices” was also a common answer (14.0%).

For the cost of home medical supplies/equipment when using U-healthcare services, 71.1% of participants selected that 50,000-100,000 KRW was reasonable, 19.3% chose 100,000-200,000 KRW and 5.3% were willing to pay 200,000-300,000 KRW for the service. Participants preferred to carry medical supplies/equipment using a “pocket-sized carry on” (28.5%) or “watch-type” (27.2%) and “belt-type” (12.3%) devices.

When asked “If new home medical supplies/equipment were provided for you, what functional/technical abilities would be most important to you?”, participants most often chose “user-friendly supplies/equipment” (47.4%). The second preference

**Table 5.** Functional needs of medical appliances (multiple choices were allowed)

Rank	Item	
1	Easy to use	108 (47.4)
2	Less preparation and fast process	71 (31.1)
3	Less painful	66 (28.9)
4	Easy to confirm test results	62 (27.2)

Values are presented as number (%).

was “less preparation for use” (31.1%), and the third was “less pain when measuring” (28.9%), followed by “easily read and fast results” (Table 5). The answers were not different between sites.

## DISCUSSION

The survey used in this was performed as a first step to establish an effective U-healthcare system. Among 228 diabetic participants older than 40 years of age, 71.1% expressed interest in using a U-healthcare system at home rather than coming to the hospital for healthcare, which suggests a substantial need for U-healthcare services in most diabetic patients. However, 81.1% of interviewees had not heard of U-healthcare services. Therefore, the concept of U-healthcare services has not been widely publicized. The term “U-healthcare” might be a reason for this unawareness because of the general population’s unfamiliarity with this term. To overcome this lack of public interest, more effort will be needed to educate the public on the universalism of healthcare services.

Considering that consumers regarded “difficulties in using supplies/equipment” and “cost of service” as barriers to the introduction of U-healthcare, practical aspects, such as ease of use and reasonable price, should be addressed and emphasized.

Although 82.0% of interviewees owned personal computers, 39.9% of them reported that they did not know how to use them. This characteristic was more evident in the age group over 60 years. As such, age should be considered when incorporating computer or web-based services with healthcare.

However, according to recent data, the internet usage rate by age steadily increased from 2002 to 2005 (39.3% → 68.7% in their 40s; 17.9% → 35.7% in their 50s; and 2.3% → 11.9% in their 60s) [12]. Therefore, the utilization rate of information technology is expected increase in the older generations so that these people will potentially make up one of the largest groups using the web in the near future. As a result, web-based U-

healthcare systems are expected to become an important tool for distributing medical/health information to the general population.

The most preferred devices for receiving healthcare services were cell phones or PDAs (40.4%). This finding reflects that patients favor devices that are easy to use and carry. In contrast, 61.4% of participants preferred to receive detailed, written manuscripts rather than simplified images and/or voice recordings. These results suggest that people want more descriptive and detailed contents than can be delivered through easily accessible devices such as personal cell phones.

A recent study by Lee et al. [13] using cellular phone-based telemedicine showed that better glucose control was obtained in type 2 diabetes patients who previously were unable to control glucose levels adequately with insulin therapy. Despite the success of telemedicine using mobile devices with easy accessibility and mobility, the authors acknowledged some difficulties in providing adequate information to the users because of their limited message content capacity. These results indicate that a web-based system is needed to supply adequate and detailed information to patients.

In introducing a web-based system of U-healthcare services to the general population (particularly to older age groups), development of a simple and user-friendly methodology is essential. Integration of mobile devices and a web-based system can be effective in accommodating the needs of the majority. Due to the wide availability of smartphones, the linking of a web-based system to smartphones will provide instant and more detailed health information to patients.

The most fundamental finding of our survey is the lack of public interest and awareness. Most people have never heard of or have only a superficial understanding of U-healthcare systems. In fact, more than two-thirds of our interviewees were unaware of the concept of a U-healthcare system.

Kim et al. [14] compared physician and patient perceptions on the effect of internet health information and found that patients who were involved in an online community expressed interest in web-based health services or medication information. These authors reported that information delivered via the internet would benefit patients by enabling them to actively receive medical services and to therefore better understand their health statuses.

More than 70% of our participants were optimistic about the benefits of using a U-healthcare service. This finding implies that if hospitals were to provide an appropriate service,

patients would be willing to use it. Therefore, establishing a customer-oriented system is essential to the success of U-healthcare systems.

The cost of service should also be considered. One-third of participants expressed concern for the financial burden of U-healthcare services. Unquestionably, Korean diabetic patients are concerned about their health costs; a reasonable cost is a strong determining factor in introducing a U-healthcare system.

In addition, difficulties in using medical supplies/equipment were considered to be a barrier in U-healthcare system usage. Technology for U-healthcare systems has to be regularly updated. Overall support from the government is critical for the technological updates and subsequent device manufacturing, which generally requires easier and more user-friendly devices or systems, particularly due to the increases in the elderly population. In a study using a web-based diabetes telemedicine system in multiple clinical settings, Choi et al. [1] suggested that a simple and user-centered system is more important than are technologically sophisticated applications.

While simple and easy-to-use applications are necessary, a system must be intricate enough to guarantee protection of personal information. To provide an individualized service to patients, personal information must be collected and stored on a server. No disclosure of personal information should be permitted in any given process. According to a study by Kim et al. [15], people who are interested in their health are willing to pay more to the individualized health service as long as their personal information is protected; privacy is a greater concern than fees.

The present study has some limitations. First, the number of interviewed participants was relatively small. Second, only diabetes patients who visited two university hospitals were selected. The characteristics of patients in a primary clinic may be very different from those in a tertiary hospital; therefore, the results cannot be generalized to people with other diseases or to the general population. Since people are becoming more interested in their health, an extended survey about U-healthcare services is warranted.

In conclusion, more than 80% of diabetic patients who visited two university hospitals had not heard of U-healthcare systems. However, after an explanation of the system, more than 70% were interested in the introduction of a U-healthcare service. Therefore, more effort is needed to increase public awareness about U-healthcare systems. For a successful in-

troduction and implementation of a U-healthcare system, a simple yet versatile application and an easy-to-use device will be critical. Finally, support from the government will be necessary to ensure the future benefits of U-healthcare systems in improving public health and reducing healthcare costs.

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