The acceptance of personal health devices among patients with chronic conditions

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Na Sun, Pei-Luen Patrick Rau*

Institute of Human Factors and Ergonomics, Department of Industrial Engineering, Tsinghua University, Beijing 100084, China

A B S T R A C T

Background: Personal health devices (PHDs) are rapidly developing and getting smarter. But little is known about chronic patients' acceptance of such PHDs.

Objective: The objective of this study is to explore how chronic patients accept PHDs and what are the main factors that predict use intention of PHDs. The results will provide suggestions for the design of PHDs and e-health services.

Method: A questionnaire survey was conducted to identify the main factors that affect chronic patients' acceptance of PHDs. Three hundred and forty-six valid responses from chronic patients were collected and the data were analyzed using exploratory factor analysis and regression analysis method. The questionnaire also included questions about respondents' experience of PHDs and preference of PHD functions. These questions help to understand lived experience of PHD users and to explain the factors that influence their use intention.

Result: Five influencing factors that predict use intention of PHDs were identified: attitude toward technology, perceived usefulness, ease of learning and availability, social support, and perceived pressure. An acceptance model of PHDs was proposed based on these factors, and suggestions for PHD designers and e-health service designers were discussed. The exploration of PHD experience indicated that ease of learning and social norm significantly influenced PHD use intention, and many respondents expressed negative opinions on the accuracy, durability and maintenance service of PHDs. Besides, people generally expressed positive attitude toward future functions of a PHD.

1. Introduction

Wearable smart devices with the function of health monitoring have become very popular over the past year. Many manufacturers have released smart watches or intelligent bracelets, such as Galaxy Gear by Samsung Group, Jawbone UP by Jawbone, and Fitbit Flex by Fitbit Inc. These devices were designed to provide users with a full health report and help them to live a healthier life. However, by storing health data in an electronic device or in the cloud storage, new problems emerge, such as management of huge amounts of health data and concerns about privacy. Besides, do people need to carry an additional device with them to keep healthy? How users view these problems determines whether or not they accept smart devices at all.

Personal health devices (PHDs) can be very helpful for chronic patients. PHDs can help them monitor their health

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status, remind them to take medicines and even allow instant communication with their physicians when connected to an e-health system. Some types of PHDs such as blood pressure monitors and glucometers are already widely used among chronic patients. However, for various reasons, some patients with chronic diseases are unwilling to use a PHD. For example, some patients do not trust personal medical devices and would rather go to hospital every week for their checkup. Some elderly patients do not know how to use a PHD and are not willing to learn new technology. Some young patients refuse to use PHDs because they are afraid of being regarded as old and sick by their friends. It is necessary to study why people do or do not accept PHDs and take these factors into consideration during the design of future PHDs.

Personal health devices are the terminal devices of e-health services. PHDs monitor users' health status and store health data in the cloud. Health care providers can access users' data in the cloud and provide diagnoses and medical treatment remotely. In developing countries like China, medical resources are scarce and unequally distributed. An e-health service could improve the quality of health care services and enable those in remote areas to easily access to medical resources. Studying users' acceptance of PHDs helps to understand users' requirements and preferences for e-health services and provide suggestions for e-health system construction. This study aimed to explore the main factors affecting PHD acceptance by patients with chronic conditions and explore chronic patients' experience of PHDs and their preference of PHD functions. The results will provide design implications for PHD designers and e-health service providers.

2. Literature review

2.1. Personal health devices

The ISO/IEEE 11073 Personal Health Data standards describe PHDs as the medical devices that "allow people to monitor their own conditions within their own homes and provide the information that such devices obtain to health care professionals and other carers." In this study, PHDs are broadly defined as medical devices used to monitor health status (instead of providing treatment) at home. Therefore, PHDs include both offline personal health monitoring devices that are only used for physical examinations, and smart PHDs that are able to connect to the Internet and store health data onto the cloud.

Currently most commercial products in the market are offline PHDs used for regular checkup, such as blood pressure monitors, blood glucose meters, thermometers and scales. Smart wearable PHDs with connection to mobile phones or laptops have got popular since the past year. In the near future, smart PHDs will be the monitoring terminals of e-health systems and allow users from different areas to have equal access to health care services. Researches have come up with several prototypes of e-health systems combined with smart PHDs, such as LiveNet [1], AMON (Advanced care and alert portable telemedical MONitor) [2], RTWPMS (Real-Time Wireless Physiological Monitoring System) [3], LifeGuard [4], MyHeart [5], HealthGear [6] and HeartToGo [7]. Smart PHDs and e-health

services will change the way people manage their health and improve the accessibility of health care services.

Personal health devices integrated with e-health systems are especially important for developing countries like China for three reasons. Firstly, the number of chronic disease patients and elderly people is steadily increasing in China, which leads to greater demands for health monitoring and medical services. Secondly, many Chinese elder people live alone far from their children, so it is difficult for them to receive timely care under some emergency circumstances. Using a smart PHD could avoid this kind of situation by continuous or regular health monitoring and remote health services. Third, the Chinese medical system is overburdened and unable to provide efficient health services for everyone. Smart PHDs and e-health system provide new opportunities to improve the accessibility and efficiency of healthcare services in China.

2.2. Acceptance of e-health technology

Technology acceptance has been thoroughly studied with many models and theories, such as the theory of reasoned action (TRA) [8], the technology acceptance model (TAM) [9], the theory of planned behavior (TPB) [10] and the innovation diffusion theory (IDT) [11]. Based on these theories, several factors that influence users' acceptance of e-health technology were identified in the literature. This study classified these factors into four categories: user characteristics, product features, attitude toward the technology and social influence, as shown in Fig. 1. The term "user" in this study refers to patients only, excluding medical professionals and system managers.

2.2.1. User characteristics
User characteristics, such as age [12–16], gender [17,18], medical literacy [19,20], self-efficacy [21], technology expertise [12–14,19,22] and patient involvement [20,23], affect their willingness to use a PHD. For example, Gaul and Ziefle [12] carried out a survey with 280 participants to examine the acceptance motives for a medical stent implemented into the body. The survey results indicated that the middle-aged generation had the highest degree of acceptance of the medical stent, and the oldest generation showed the lowest acceptance level and highest rating on potential barriers. Motives to use a PHDs are also different among users from different generations. The oldest generation used a PHD in order to reduce the frequency of visiting the doctor, while the other generations stressed maintaining their independence as the main acceptance driver.

2.2.2. Product features
Product features are the basic requirements for users of PHDs, including functions [13,22,24,25], reliability [12,26], terminal form [12,17,22,24], cost [14,15,22], esthetic appearance [17] and usability and usefulness [14,15,17,18,21–23,27,28]. Scheermesser et al. [13] conducted two case studies in pre- and post-clinical health care to explore the factors that facilitate or inhibit user acceptance of pervasive computing in health care. The results showed that perceived medical usefulness and ease of use are two influencing factors of acceptance. These two factors also proved to be influential in another