Developing a Health-Enabling Service System Combining Wearable Device and Personal Health Records for Older Adults

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Abstract. The use of wearable devices in health promotion service is less common among older adults. The goal of this project is to validate the health-enabling innovative service for seniors combining wearable device and personal health records ("My Health Bank") from National Health Insurance Administration (NHIA). ComCare, a health-enabling service system with an app, is built to integrate the medical records and physiological index data from three parts: data collected via wearable sensors, national personal health record storage ("My Health Bank" from NHIA), and a health management IoT cloud. The user-friendly ComCare service and app expects to provide the following two major benefits:

1. Health and Physical Assessment: With the help of wearable device and IoT cloud networks to collect activity (movement) records, daily physiological measurements (blood pressure, blood sugar, body temperature, BMI, heart rate), and medical records/prescriptions from NHIA, the family members and caregivers are fully aware of the senior's health conditions.
2. Healthcare Service Notification: ComCare provides real-time monitoring of the elderly's vital signs, and the corresponding care centers will be notified upon detection of abnormality. It ensures an instant healthcare and provides tracking and reporting service to promote healthy lifestyles among older adults.

This research provides an empirical study to explore and analyze the effectiveness of senior health promotion using data from wearable devices and "My Health Bank". The project will adopt a "one-group pretest-posttest" design and recruit 60 daycare seniors to participate in the next phase. Questionnaires will be completed and analyzed to generate knowledge of participants' subjective changes towards quality of life and evaluate the Technology Acceptance Model (TAM). The results of this study may benefit the Ministry of Health and Welfare for consideration in policy-making process and developing a business model for the senior care industry.

Keywords: Wearable device · Personal health records · IoT cloud networks · Healthcare Service Notification

1 Introduction

In recent years, wearable devices and IoT have become very popular. Portable wearable devices that can measure and record the amount of exercise, along with IoT, are being used as a tool to manage exercise systematically and scientifically in health promotion. Also, preventive medicine, companion diagnostics and big data analysis that incorporate sensor and data analysis technology have gradually become the mainstream in medicine. This has created business opportunities in the field of "precision medicine" that can ensure better efficiency and reduce waste of resources in the field of medicine. With the development of ICT and wearable devices, the traditional patient-centered model of healthcare has changed. Medical and healthcare industries now have access to a patient's health data via different ways. With that, the "continuous, symptom-centered medical care" model has emerged.

As many people need to have regular physiological measurements, the major wearable device companies such as Apple, Google, Samsung and Xiaomi have launched lightweight, easy-to-carry wearable devices so that the users can monitor their own health conditions continuously over a long period of time. At the same time, these companies hope to provide innovative services with the development of big data by incorporating physiological sensors into their products as well as by devising back-end application platforms and apps. The purpose is to promote the feasibility and convenience of wearable devices so that they will become an important part of future medicine. The major challenge is the lack of a platform which integrates such a huge amount of data collected via various devices. Thus these physiological statistics cannot be incorporated into one's health record, which undermines the effectiveness of health analytics. To tackle with the problem, this research has developed a platform called "ComCare" to integrate data and analysis collected from different devices in order to provide users with detailed health information.

2 Literature Review

The chapter includes three parts: (1) a brief introduction on the development of wearable devices in healthcare, (2) the current situations of Taiwan's National Health Insurance, and (3) an introduction on "My Health Bank".

2.1 The Development of Wearable Devices in Healthcare

According to a research conducted by III (Institute for Information Industry), people in Taiwan using wearable devices to record their health information will reach 930,000 in 2015 [1]. Currently the wearable devices are developed in three fields: exercise assistance, health management and medical assistance. The first two fields can be applied, for example, to help office workers keep themselves fit and reduce stress (e.g. weight control). The potential market of such use is huge yet lacks high demand since people tend to ignore the importance of body fitness unless they are experiencing deterioration in health or facing diseases.

On the other hand, the field of wearable devices as medical assistance (an extension of medical equipment) is mainly applied for symptom management, diagnosis or monitoring in elderly or patients with chronic disease. If adopted in medical institutes, wearable devices as medical assistance can cover a large population of users, which means the potential market is considerably huge.

According to a survey conducted by the Health Promotion Administration (under the Ministry of Health and Welfare), the percentage of Taiwanese population that exercise regularly has risen from 26.1% in 2010 to 33.4% in 2015. This is the result of the government's continuous promotion. In the past, smart bracelets were mainly defined as sport equipment that only measured statistics such as calories burned, steps or distance walked/run, etc. [2]. Since 2014, manufacturers have started to further collect users' more delicate movements and thus acquired users' daily behavior pattern as well. With such, after analyzing a certain user's daily routine behavior, the system can send notifications or reminders (e.g. Your working hours are too long, Please get up and stretch, etc.) in order to help the user manage his/her health conditions more easily. The built-in sensors that used to measure steps can now only measure physiological statistics such as pulse, blood pressure, blood oxygen, etc. [3]. Besides collecting physiological statistics, it is also expected that data collected via smart bracelets will be able to analyze users' mental status (e.g. stress index, fatigue, etc.). Through comprehensive analysis, the system can also send out reminders or "tips" to help users accommodate their own mental health conditions.

Wearable devices can make it easier for researchers to access the health-related data of the users, but the utilization of wearable devices in elderly is yet to be comprehensively planned. Due to the fact that current studies (regarding types of devices, users' habits and data collection) mainly focus on the utilization of wearable devices among younger adults in good health, it is expected that more research should be done to discuss how wearable devices can benefit the elderly in the future [4].

2.2   National Health Insurance in Taiwan

Launched in 1995, the National Health Insurance (NHI) program is a compulsory social insurance which provides healthcare coverage to all population in Taiwan. The purpose is to ensure that the economically disadvantaged can also receive fair and quality care at affordable costs.

The focus of NHI has shifted from universal healthcare coverage and medical readiness (availability of healthcare resources) to quality medical services. Firstly, transparency in healthcare information is made to protect people's right to know. Secondly, quality care for the disadvantaged in remote areas is enhanced. Finally, a patient-centered care focus is emphasized. Programs and projects were launched accordingly to upscale medical service quality and efficiency.

Through the collaboration of NHIA (National Health Insurance Administration), hospitals, clinics and the public, the NHI system currently covers over 99% of Taiwan's population [5]. The dedication has also elevated medical service quality and the quality of care, as well as enhanced electronic network services. Administrative

efficiency and service quality are also bettered. More underprivileged people are assisted and taken care of.

2.3   Introduction on "My Health Bank"

"My Health Bank" is a cloud-based inquiry service from NHIA which provides 12 different kinds of data from cross-institute, including outpatient data, medication records, medical examination reports, etc. It provides an easy access and a convenient self-management tool for the insured to check on their personal information whenever needed. Using either a "citizen digital certificate" or a "password-registered NHI card" to log into "My Health Bank" system, the user can check on his/her personal data and even download it. NHIA hopes to make "My Health Bank" more accessible and convenient for the insured and to develop its functions to the fullest in the future [6].

3   Research Methods

The "ComCare Health Information Integration Platform (abbreviated as 'ComCare')" is established to collect the exercise data sent in via wearable and other IoT devices and concurrently download medical records from "My Health Bank" before the data is analyzed. With the analysis and evaluation of ComCare, users' personal health information can be presented in a clear, understandable fashion for the users and/or the caregivers (e.g. medical professionals, care center staff, family members, etc.). They will also receive personalized messages or tips that remind the users to pay attention to particular aspects of their health conditions.

3.1   Information Architecture of the ComCare Platform

The ComCare Platform has a multi-layered architecture (as illustrated in Fig. 1). It mainly consists of (1) external data retrieval APIs, (2) internal modules for smart health management and (3) data visualization APIs. Following is a more detailed introduction of the information architecture:

- External data retrieval APIs Layer collects the data from wearable and other IoT devices, "My Health Bank" and other open platforms. It offers a standardized interface for all kinds of data. It also integrates and anonymizes heterogeneous data (physiological measurements and statistics). Individual users can transmit their data to the ComCare Platform via wearable devices, physiological measurement devices, physiological signal collection gateways or private cloud services.
- Internal modules for smart health management consist of modules that function in the following aspects: Health Management, Health Warning, Healthy Lifestyle Planning, Behavioral Analysis, Commercial Promotion and Information Security. Based on the data transmitted via the external data retrieval APIs, this layer of architecture processes data for different kinds of value-add applications for the users.

- Data visualization APIs Layer, as the final layer, presents the processed data that caters to the needs of individuals, healthcare providers or other health-related product manufacturers. Before accessing any information, individuals or institutes first have to be authorized and certified by apps in order to ensure information security.
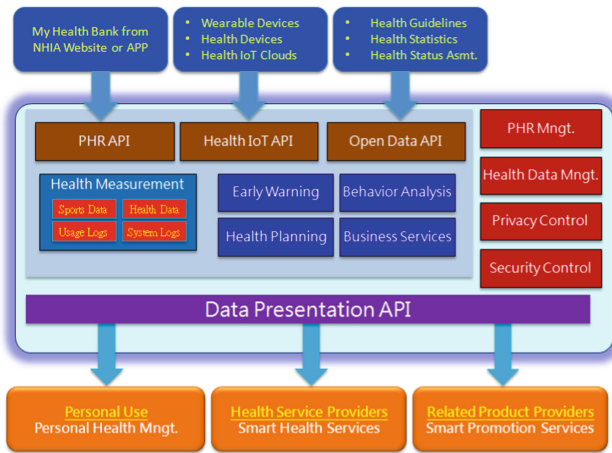

Fig. 1. Information architecture of the research

3.2 Functions of the ComCare Platform

Long-term care for elderly has shifted its main focus from traditional treatment for diseases to the prevention of mental illness and promotion of health. With its accessibility via ICT, integration capability and preventive nature, ComCare is expected to be applied to elderly care and boost the efficiency of elderly health management and quality of care via comprehensive integration of resources.

There are eight main functions on the ComCare Login Dashboard (illustrated in Fig. 2). The applications can be divided into two categories for users:

1. Application of data collected/analyzed: ComCare analyzes data differently based on different user groups. For example, blood pressure and blood sugar will be assessed based on users' age. If the result is abnormal, the system will signal to warn the user. As for chronic disease patients suffering from cardiovascular diseases or diabetes, the data will be instantly analyzed to help family members or caregivers to take timely action. The ComCare Platform not only allows the users to keep track of physiological records but also practice caution in advance when abnormality is detected.

2. Automatic mobile recording service: In the past, physiological data were measured by doctors or nurses and the paper/electronic medical records were kept in the hospitals/clinics. With the development of home measurement equipments, it has

become a trend to take physiological measurements at home for the youth. Yet the elders or patients usually have difficulties using such equipments by themselves. ComCare is user-friendly and efficient. It automatically collects and uploads data to the platform via the Internet, saving labor works and ensuring correctness (no typos in transcription).

Fig. 2. ComCare login dashboard

4   Conclusion and Discussion

4.1   Future Prospect

A living lab will be designed to explore and analyze the data collected via wearable devices, physiological measurement devices and "My Health Bank". The data will be assessed to determine the effectiveness in health promotion. "One-group pretest-posttest" design will be conducted in a daycare center with 60 participants with collaboration of local medical institutes. The participants will experience the ComCare service in a time period of 12 weeks and fill out questionnaires at the end to find out their acceptance of the ComCare Platform. With such, the research can validate whether the experiment design in the living lab is favorable to promote users' health.

4.2   Conclusion

The wearable devices mainly target the public, among which smart watches, bracelets or collars are the dominant products in the market. However, smart wearables for medical use are becoming more popular and promising. This kind of medical devices helps people record and access their physiological signals more easily. The prevention, diagnosis, alleviation and treatment of diseases can be done in a more accurate and

hassle-free manner. The Government is also advocating the use of "My Health Bank" to help the public better manage their medical and medication records, raise awareness of health among people and assist individuals to better manage their health.

Currently there are different apps and cloud services available in the market, but not a unified system that can integrate all the data information. The feature of ComCare aims to analyze the data collected in order to find out the correlation between disease and lifestyle. Once the correlation is established, it can help the medical professionals to provide professional advice. We believe this study will raise the awareness of health management in the public. In addition, with the long-term program of ComCare launched by the Ministry of Health and Welfare, the caregivers can plan their schedules and work assignments more efficiently and effectively. The result will also raise the overall quality of care noticeably and enormously.

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