

## Original article

## Social networking-based personal home telehealth system: A pilot study

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## ABSTRACT

**Background/Purpose:** Although useful vital sign monitoring equipment and information communication technologies are readily available, many researchers and businesses are still attempting to expand coverage, yet expectations for the widespread adoption of home telehealth services have not been realized in Taiwan. The practical application of such systems are often found to be too complicated, too costly, and users, both older adults and professional caregivers, lack adequate motivation or experience to use the systems effectively.

**Methods:** This paper describes a personal home telehealth system—Care Deliver Frame (CDF)—for older adults based on social networking, which transforms the home telehealth system into a platform for communication and care between older adults and their family members. The system is linked to existing social networking sites such as Facebook to encourage interpersonal communication between older adults and younger family members. The home telehealth system is implemented on personal mobile devices in the form of Apps. The scale and cost required for implementing the personal home telehealth system are greatly reduced.

**Results:** From the pilot study of user evaluation, CDF was well accepted by the older participants and their children. Even though this evaluation is based upon a small sample size, it provides a good insight into participants' behaviors, preferences, and expectations, which helps to determine the future development of CDF.

**Conclusion:** CDF presented in this paper extends the value of a home telehealth system from the provision of health care to enhancing older adults' interpersonal communication and social participation.

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## 1. Introduction

## 1.1. Typical home telehealth systems

Telehomecare, or home telehealth, can be defined as “the use of information and communication technologies to enable effective delivery and management of health services at a patient's residence”.<sup>1</sup> Having a home telehealth system allows information and communication technologies (ICT) to assist in caring for older adults and allows them the dignity of remaining in their own home for as long as possible, which is an important health management trend in an aging society.

The current market provides a variety of products and services designed and launched with different needs and application scenarios in mind for the care of older adults. For example, the Personal Emergency Response System (PERS) enables the user to call for help in an emergency by pushing a button. The Lifeline System (<http://www.lifelinesys.com>; Philips Lifeline, Massachusetts, USA) founded in 1974 is one of the earliest examples of PERS. Activities of daily living (ADLs) refer to the daily tasks that are required for personal self-care and independent living, such as eating, dressing, or bathing.<sup>2</sup> The ageing process is an expected cause of limiting ADL performance that changes from advanced or moderate ADLs to a lower, basic ADL level.<sup>3</sup> Traditional ADL assessments for older adults usually rely on subjective judgments by clinical or specialized personnel. The Lifeline Vi System, developed by Tunstall Healthcare (UK) Ltd. (<http://www.tunstall.com>, Whitley, Yorkshire, UK), provides a hub for telecare in the home and is compatible with

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a wide range of sensors for monitoring the daily living of older adults in a nonintrusive way.

Long-term wellness monitoring provides services that are designed for older adults who have chronic diseases such as diabetes. For example, the Health Buddy System (<http://www.bosch-telehealth.com>) collects and transmits vital signs data, such as blood pressure, blood glucose, weight, etc., to a secure data center. Caregivers and family members have instant access to patient data on computers or mobile devices. The medical community (doctors, nurses, emergency response workers) also shares the long-term monitoring data.

Telerehabilitation or e-rehabilitation involves the delivery of therapeutic rehabilitation interventions using telecommunication technologies.<sup>4,5</sup> Telerehabilitation programs offer more convenient and efficient service choices for patients or older adults undergoing rehabilitation.<sup>6</sup> Using advanced technologies such as motion tracking, motion detecting, computer graphics, and visual technologies, a patient can be treated at home and learn the proper corrective movements without the need to go to hospital, thus saving time, cost, and manpower.<sup>7,8</sup>

As described in the above-mentioned cases, home telehealth systems generally focus on building connections between home environments and home telehealth service providers. The technical emphasis is often on establishing an information channel for health-related data transmission between homes and home telehealth service providers, and a variety of health-related data are stored in a centralized database for further analysis and processing.

## 1.2. Challenges to home telehealth systems

In addition to health problems, the greatest risks for older adults are isolation and loneliness. Isolation refers to a person being physically separated from others, such as living alone; loneliness, in contrast, refers to a person who mentally feels lonely.<sup>9</sup> In Stockholm, a survey among older adults shows that 35% of 1725 people over the age of 75 years had experienced loneliness. Loneliness easily causes disorders in an older adult's life such as depression and insomnia.<sup>10</sup> Steptoe et al<sup>11</sup> also assessed social isolation in 6500 men and women aged 52 years and older who had participated in civic organizations from 2004 to 2005. After conducting interviews and statistical analysis for 8 years, the results showed that both isolation and loneliness were significantly associated with mortality. Some studies also showed that social interactions are essential especially for older adults, to reduce social isolation, loneliness, and improve psychological well-being.<sup>12–14</sup>

Most home telehealth systems focus on health management and health care for older adults. However, from a psychological perspective, more attention should be paid to communication and emotional needs of older adults as a central facet of elder care. Older adults are more likely to make contact and share their life experiences or emotions with family members and relatives rather than with professional caregivers.

## 1.3. New frontiers of ICT and the concept of Web 2.0 in home telehealth

Mobile devices such as smartphones and tablets have become popular in the past few years. Compared with dedicated home telehealth devices, such as home gateways, mobile devices are easily available, portable, and relatively inexpensive for both caregivers and older adults. A home telehealth system can be in the form of an App on a mobile device, which can be downloaded from a digital application distribution platform such as Google Play and Apple App Store.

From a usability point of view, the availability of 7–10.5 inch touch screens is the key reason why tablets are more popular among older adults. It can accommodate for some age-related limitations and provide better image resolution and multimedia experience than a smartphone. Caprani et al<sup>15</sup> pointed out that touch screens with virtual buttons provide easier hand–eye coordination for older adults than mice and keyboards. It is easier for older adults to learn to use tablets because of this direct manipulation.

The use of a cloud service in a home telehealth system can enable dynamic scaling to meet the needs of the user. Caregivers do not need to build a server or allocate IT staff to manage it. The concept of Web 2.0, first raised by O'Reilly in 2004, has been described as a “web as a platform” for delivering services. Beyond the static pages of earlier websites, Web 2.0 sites may allow users to interact and collaborate with each other in a social media dialogue as creators of user-generated content in a virtual community, such as blogs and video-sharing sites. Today, in the era of Web 2.0, the focus is switched to connecting online activities with associated friends in the real or virtual world. Social networking has the potential to become a key driver of home telehealth systems.

### 1.4. Social networking and older adults

An online social networking site is a web-based service that allows users to construct a public or semi-public profile, connect with other associated users, as well as view and traverse connections that were made by others within the system.<sup>16</sup> In many peoples' daily lives, online social networking sites such as Facebook have become an integral interpersonal communication channel. Facebook officially reached one billion active users in September 2012, which means that one out of every seven people on planet earth has an active Facebook account. In Taiwan, with 13 million active users in March 2013, more than half of the population in Taiwan (23 million) is using Facebook, spending an average of 317 minutes per month on Facebook and browsing 468 pages.<sup>17</sup> However, in April 2014, only 6.7% of Facebook users were over 55 years old, which indicates that Taiwan's older adults are less involved in participating in social networking sites.<sup>18</sup>

Many specialized sites have been established for older adults with a specific user interface design, such as the Genkvetch social network site (<http://www.genkvetch.com>) and ThirdAge (<http://www.thirdage.com>). These sites usually use large fonts, simple color schemes, and receive high marks for readability. However, the user interfaces of most social networking sites are still too complicated for many older adults, especially for those who are not familiar with using a computer and surfing the internet. A barrier still exists for older adults who wish to join social networking sites.

Linking with social networking sites can extend the value of a home telehealth system from the provision of health care to enhancing older adults' interpersonal communication and social participation. Social networking sites such as Twitter, Google+, and Facebook often provide application programming interfaces (APIs), which can be used to link home telehealth systems with social networking sites. A few telehealth systems already provide social networking functions. Healthcare4Life is a novel web-based telehealth system that combines the social networking API to enable older adults to take charge of their own health.<sup>19</sup> GrandCare System (<http://www.grandcare.com>) provided by TellaBoomer TeleCare Services is an all-in-one telehealth device that combines ADL sensors, blood pressure/blood glucose meters, and social networking. Family and friends can send pictures, messages, set up calendar events, and even upload family videos to the social networking site specifically set up for the users.<sup>20</sup>

### 1.5. The purpose of this research

Although useful vital sign monitoring equipment and information communication technologies are readily available, many researchers and businesses are still attempting to expand coverage, yet expectations for the widespread adoption of telehealth services have not been realized in Taiwan. The practical application of such systems are often found to be too complicated, too costly, and users, both older adults and caregivers, lack adequate motivation or experience to use the systems effectively.

Care Deliver Frame (CDF), a personal home telehealth system based on social networking, is presented here. As mentioned earlier, technically home telehealth systems generally focus on building connections between home environments and home telehealth service providers. On the contrary, CDF aims to connect older adults with children, family members, and caregivers in a personalized way. More attention is paid to communication and the emotional needs of older adults. In addition to tracking vital sign data and providing timely health care to older adults, several family members can also join together and form a small “family social network” to have interpersonal communication and share life experiences with the older adults.

## 2. Methods

### 2.1. Structure of CDF

Fig. 1 illustrates the structure of CDF. In this structure, a tablet in which the CDF App is installed serves as the core for vital sign measurement data collection and transmission. Vital sign measurement data from various devices, such as blood pressure/glucose meters and weight scales, are transmitted via Bluetooth to the tablet. Under the SSL and HTTPS data transmission security of Facebook, data are encrypted and then posted to the older adult's Facebook timeline by using the one-touch data upload button on the CDF App interface. Facebook has also become the “user interface” of CDF for younger children and family members who are “Facebook friends” of the older adult. Under appropriate Facebook privacy

settings, children and family members can be allowed to browse older adult's vital sign measurement data as well as posting caring messages, photos, and videos using the regular Facebook App or Facebook website. The older adult is able to read these messages from the simplified user interface of the CDF App on the tablet. The professional caregiver who is a “Facebook friend” of the older adult is allowed to use the “Comm & Care” App installed on the smartphone to retrieve vital sign measurement data stored in Facebook. The “Comm & Care” App provides standard home telehealth functions such as multiple user management, graphical display, and data analysis event alert and export. When more complicated health management services are needed, the CDF App can still transmit vital sign measurement data to a centralized database.

Technically, CDF should be the smallest possible home telehealth system structure. A family can be a unit for the home telehealth system by simply installing the CDF App. It is not necessary to subscribe for service from a home telehealth service provider. Children and family members are responsible for the caring for the older adults. Using existing mobile devices, the infrastructure required is minimal. The system can be easily adapted and implemented in a home environment at very low cost. Integrating with the online social networking sites such as Facebook, the familiar user interfaces, and operations increase the willingness and motivation of the younger children and family members to actively use the system.

### 2.2. Using the personal home telehealth system CDF

To prepare for using the home telehealth system CDF, the older adult should first have a Facebook account. Children and family members can be added as “Facebook friends” with the appropriate privacy settings. The CDF App can be downloaded from Google Play and installed in the older adult's tablet, and the older adult's Facebook account is set as the default login account. Vital sign measurement devices with Bluetooth connection should also be paired with the tablet. Currently, a blood pressure/glucose meter and a weight scale are connected with CDF via Bluetooth. As shown in Fig. 2, the older adult can then log in to the CDF App to start using CDF.

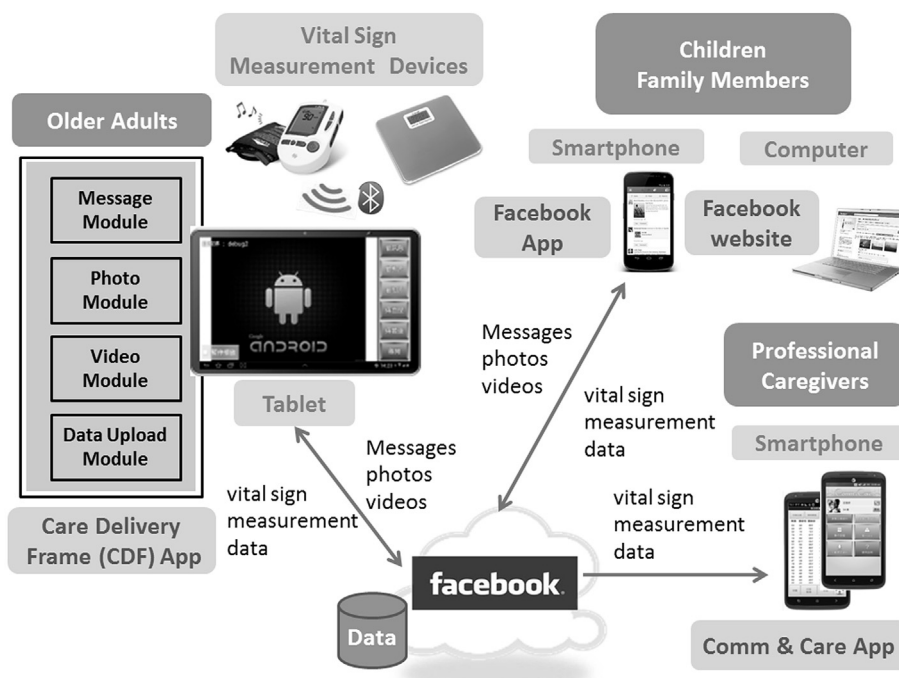


Fig. 1. Structure of the Care Deliver Frame (CDF).



Fig. 2. Using an older adult's Facebook account to log into the Care Deliver Frame (CDF) App and view the welcome frame.

As shown in Fig. 3, the older adult transmits the vital sign measurements via Bluetooth to the tablet using the one-touch upload button on the CDF App. The data is then automatically uploaded to the older adult's timeline on Facebook, which can be read by his/her adult's Facebook friends such as children and family members, just like ordinary Facebook messages. Children and family members can also share caring messages, photos, and videos with the older adult, as they normally communicate with their friends on Facebook. New messages, photos, and videos will pop up on the interface of the CDF App, which is designed in the form of a digital photo frame. As shown in Fig. 4, the older adult can select several predefined message buttons or use Google Speech for voice input to respond. After reading and closing messages in the CDF App, a "Like" by the older adult will be added to this message on Facebook.

Professional caregivers can also be included as the older adult's Facebook friends. With the appropriate privacy settings, only professional caregivers can read the vital sign measurement data posted on the older adult's Facebook timeline. As mentioned earlier, the Comm & Care App installed on the smartphone can be used to retrieve vital sign measurement data posted on the older adult's Facebook timeline. The standard home telehealth functions, such as multiple user management, graphical display, and data analysis export and event alert, are provided in the Comm & Care App (Fig. 5).

### 2.3. User evaluation—a pilot study

A pilot study of user evaluation of CDF was arranged to explore the experiences in usability, including using the tablet, the home telehealth, and the social networking functions of CDF, for both older adults and family members. We also aimed to evaluate whether CDF enhances the motivation to use the home telehealth system and increases interactions between older adults and family members. This evaluation was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. Participants gave informed consent prior to their inclusion in the evaluation.

During the 5-month period of evaluation, a tablet, a blood pressure/glucose meter, and 150 blood glucose test strips were provided to each participant. Owing to budget limitations, a total of 10 older adults who were not living with their children were recruited in this pilot study. Nine participants were over 65 years old (5 participants were over 70 years). One participant was a 57-year-old male. He was retired, living alone, and suffered from hypertension and diabetes, a target user that CDF is specifically designed for. Among the 10 participants, only one older adult had experience using computers. Three older adults suffered from hypertension, and two had diabetes.

Owing to the small research population and less user quantitative data, this research also used qualitative content analysis (QCA) to obtain complete and straightforward user feedbacks. There are three distinct types in current QCA applications: conventional, directed, and summative content analysis.<sup>21</sup> This research used conventional content analysis, in which the researcher interviews participants and summarizes the data content. In this evaluation, the interview questions progressed from general topics of personal backgrounds to specific topics related to the home telehealth system.

In the first part of the interview, close-ended questions were used to understand the general ways of communication and usability of tablets, vital sign measurement devices, and social networking sites among participants and their family members before using the CDF, such as "Have you ever heard about Facebook?" or "Do you have your own tablet?" Then, the moderator introduced the concept and operations of the CDF, and taught family members how to help older adults apply for a Facebook account and install CDF Apps. A system manual was also provided. After 1 week, the moderator interviewed family members and used the open-ended questions to understand any difficulties in the installation process.

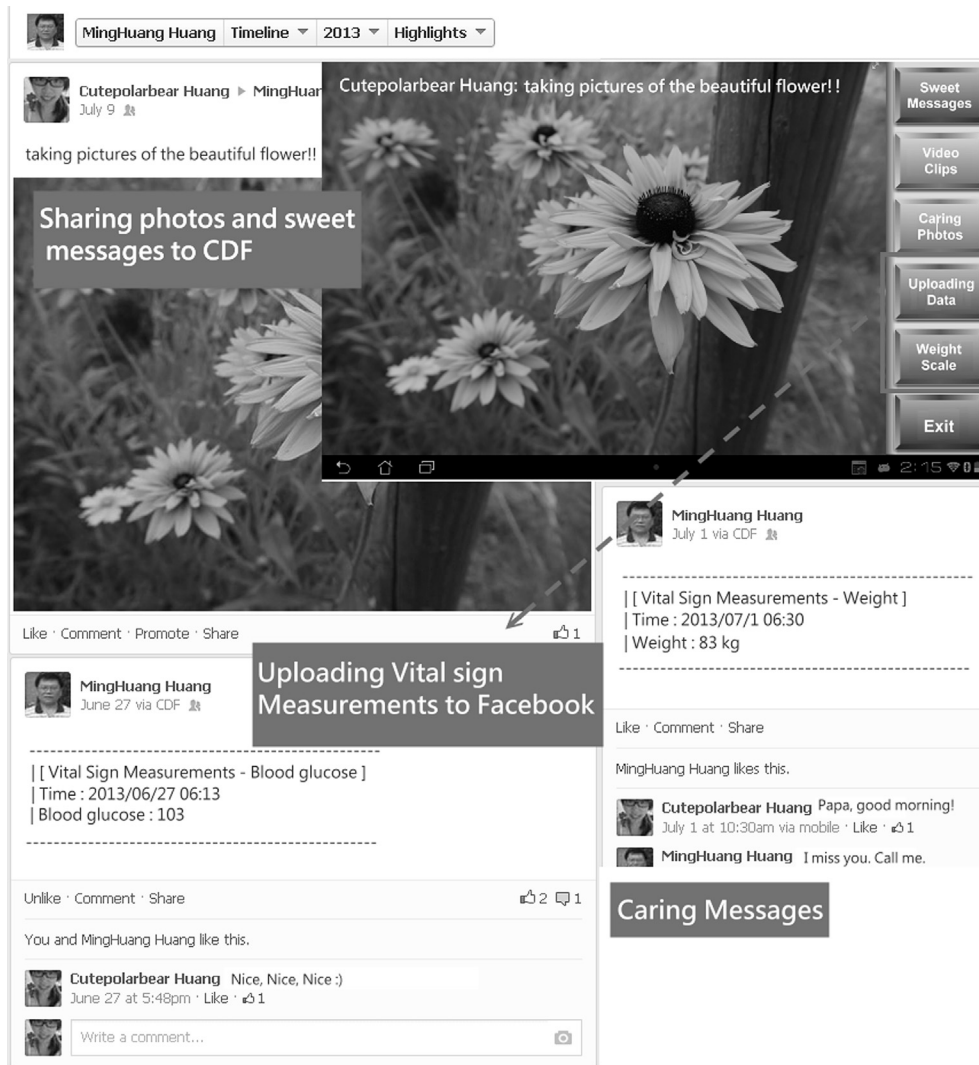
In the second part of the interview, a modified version of the technology acceptance model (TAM)<sup>22,23</sup> was investigated that included questions used to access participant perceptions of CDF, ease of use, and willingness to use, as well as change in relationships and communication between participants and family members after using CDF for more than 3 months. The interview of each participant was recorded before data analysis.

## 3. Results

### 3.1. Participants' interview summary

Under users' permission, four participants' vital sign measurement data, photos, caring messages, video clips, and responses were collected manually from their Facebook timelines in order to investigate the trend and pattern using CDF. Table 1 shows the biodata; an average number of interactions occurred through CDF for the four participants collected over more than 5 months. Before using CDF, the four participants had never used Facebook. During the evaluation period, each participant had 1.79–3.50 times the number of interactions per day in Facebook by using CDF. Table 1 also shows the percentage of different categories of interaction, including vital sign measurements, messages, and photos/videos of the four participants. Vital sign measurement was the most frequent category of interaction (53.71–82.81%) for the four participants.

The content analysis from 10 participants is summarized below. The views expressed are described under these same headings, with quotes from participants in italics.



**Fig. 3.** Vital sign measurement data can be uploaded onto the timeline of the older adult's Facebook account through the Care Deliver Frame (CDF) App. Family members, children, and friends can share caring messages and photos with the older adult on Facebook.

### 3.2. Part I

#### 3.2.1. Realizing the difficulties for family members in installation processes

In preparing for CDF, most children found pairing the tablet and vital sign measurement devices by Bluetooth to be an easy step. All children could successfully apply for a Facebook account for the older adults and helped them to add other family members as their Facebook friends. However, all of them did not know how to establish the privacy settings in Facebook and felt it was a difficult step for them for the first time. Only one adult child did not have experience downloading and installing Apps from Google Play. After reading the user manual, all adult children felt this was an easy step and successfully installed the CDF App.

#### 3.2.2. Analyzing ways of communication between older adults and family members, and understanding usability experiences of the tablet, home telehealth systems, and social networking sites for older adults and family members

From the interview, eight of the 10 participants had never used computers and the internet previously, and all participants were

not familiar with their operations. Six participants did not know how to type and nine participants thought learning how to operate the new technological products were very difficult for them.

All participants communicated with their children who do not live with them by phone, mostly about once a week. In the interview with the children of the 10 participants, eight mentioned that they did not have topics to occasionally talk about with their parents.

For usability experiences of tablets and Facebook, only one participant (Case C) had his own tablet before the evaluation, whereas all the others knew about "tablets" from sources such as TV news. Adult children of all cases use Facebook frequently. Case C knew how to play games and browse websites on the tablet. He also was familiar with Facebook before the evaluation, but he thought the functions and interfaces were too complex for him. "The touch screen is easier for me. In the past, I did not know how to type. I can only use one finger to press the keyboard. I wasted a lot of time just to finish several words." (Case C – older adult).

All participants had experience using vital sign measurement devices. Only one of them measured vital signs every day before using CDF. Five of the 10 participants almost never measured their



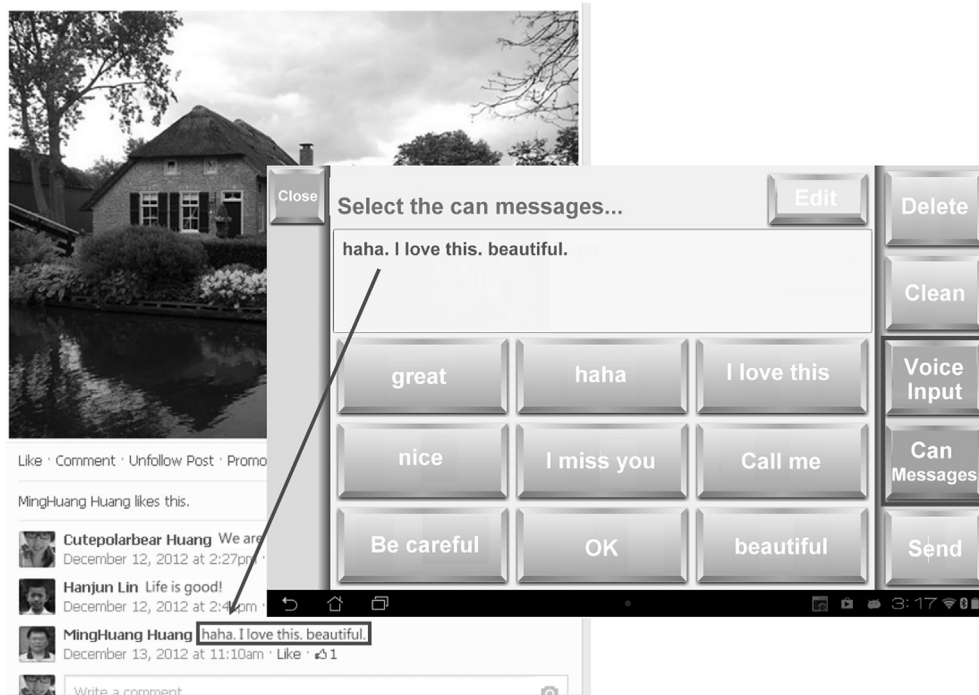


Fig. 4. The older adult can select several predefined message buttons on the Care Deliver Frame (CDF) App to respond to the Facebook messages.



Fig. 5. Professional caregivers can install the “Comm & Care” App on their smartphones and use the standard home telehealth functions.

vital signs. After being taught by their family members, all participants could operate the vital sign measurement devices themselves. Note that the participants showed good compliance in vital sign measurement during the evaluation. As shown in Table 1, for the four participants who were willing to share their Facebook information, each participant measured and transmitted blood pressure data 1.14 times per day on average, and the three participants who had diabetes measured and transmitted blood glucose data 1.11 times per day on average.

### 3.3. Part II

#### 3.3.1. Understanding the suggestions from participants after using the system

3.3.1.1. Interface design of CDF. From the interview about the user interface design of CDF, 10 participants generally liked the user interface, which is clean, iconic, and colorful. The vertical menu on the right makes it easy for participants to identify and choose key functionalities. One participant (Case B) described that colorful buttons

**Table 1**  
Biodata, average number of interactions, and percentages of different interactions occurring through Care Deliver Frame (CDF).

Case	Biodata (includes age, sex, hypertension, and diabetes)	Average number and percentages of different interactions occurring through CDF						
		Blood pressure measurements	Blood glucose measurements	Caring messages (from family members)	Responses (from older adults)	Photos (from family members)	Video clips (from family members)	Total number of interactions
A	70–79 y, female, hypertension, and diabetes	1.01 53.71%	0.87	0.65 22.29%	0.13	0.75 24.00%	0.09	3.50 100%
B	60–69 y, male, hypertension, and diabetes	1.10 76.45%	1.01	0.35 16.67%	0.11	0.18 6.88%	0.01	2.76 100%
C	55–60 y, male, hypertension, and diabetes	1.44 82.81%	1.45	0.33 15.19%	0.20	0.05 2.01%	0.02	3.49 100%
D	60–69 y, male, hypertension	1.00 55.87%	0.00	0.49 28.49%	0.02	0.28 15.64%	0.00	1.79 100%

immediately attracted his attention. Participants also mentioned that an alarm sound accompanied by a button could let them know that they had touched the button. For all adult children, using existing interfaces of the Facebook App or the Facebook website to read their parents' vital sign measurements and feed the caring messages was easy and made them willing to use CDF. *"It takes a bit of time to learn for the first time. But CDF uses different colors to represent different purposes, and it makes it easy for me to identify."* (Case B – older adult).

**3.3.1.2. Function design of CDF.** Almost all of the participants expressed that CDF is user-friendly. The participant is only required to deal with one thing at a time. All participants needed assistance for the first time, especially to deal with the Facebook login and the Bluetooth pairing problem between vital sign measurement devices and the tablet.

For vital sign measurement transmission, all participants were satisfied with the one button uploading function. However, in this personal home telehealth system, adult children or professional caregivers can use the "Comm & Care" App to draw graphs and export the vital sign measurement data report for participants. Two participants suggested adding further graph and data display functions in CDF. Participants described that data visualization helps them to understand their health conditions easily. All participants mentioned that the canned messages and voice input function would be very useful for them to generate the response, especially for those who are not good at typing.

### 3.3.2. Changes in relationship and communication between older adults and their family members

By using the tablet as the main device and accompanying simple user interfaces of CDF, participants described that it was exciting and they even looked forward to reading the caring messages and photos from family members, especially for those whose children are living abroad. All cases (includes participants and their children) felt it generated a new communication channel among them. Six children described that they were used to contact with participants by phone, but photos, vital sign measurements, and caring messages that were shared with participants on CDF provided them with some conversation topics. Most participants felt the conversation gap between them and their children was reduced. None of the participants ever used Facebook before the evaluation. During the evaluation, two older participants (Case A and Case B) requested to learn how to use the "full version" of the regular Facebook App. Three participants also described that uploading the vital sign measurements to Facebook had a discipline effect for them.

## 4. Discussion

This pilot study user evaluation was conducted in Taiwan. Therefore, the characteristics of the content analysis should be considered as

a culturally specific case study. The results of the evaluation are discussed here. (1) Tablets are well accepted by most participants. After the evaluation, most older adults requested to have their own tablets and were willing to learn other functions on the tablet. By contrast, some older adults were reluctant in changing their current vital sign measurement devices. (2) Social support from the encouragement of children through the use of CDF is helpful in compliance with vital sign measurement of the participants for telehealth purposes. Using Facebook as the interface also increased the motivation of the younger adult children to read and respond to the vital sign measurement data. (3) There was high satisfaction in encouraging communication between older adults and their adult children by using CDF. Sharing photos and videos on CDF enriched the content of conversations. (4) During the evaluation, some older adults started to appreciate the interaction on Facebook, and requested to use the "full version" of the regular Facebook App or the Facebook website.

In summary, the personal home telehealth system based on social networking presented in this paper extends the value of a home telehealth system from the provision of health care to enhancing older adults' interpersonal communication and social participation. There are two technical features of the CDF that are different from traditional home telehealth systems. (1) Users can use their own tablets to install the CDF App, instead of purchasing or renting a dedicated machine or contracting for a service from a home telehealth service provider. The personal home telehealth system can be built by downloading two Apps from an online App store such as Google Play, which is technically the smallest possible home telehealth system. (2) Facebook is used as a "cloud server" to store vital sign measurement data, as well as a "user interface" of the personal home telehealth system. Family members, adult children, or caregivers interact with older adults by using Facebook's built-in functions such as message and photo sharing while using the desired privacy settings. This approach expands the value of the home telehealth system from health care to increasing the level of interpersonal communication and social participation of the older adults. The familiar user interface and operations of Facebook also increase the willingness and motivation of family members, adult children, and caregivers to use the system actively.

From the pilot study of user evaluation, CDF was well accepted by the older participants and their adult children. Even though this evaluation is based on a small sample size, it provides a good insight into participants' behaviors, preferences, and expectations, which helps to determine the future development of CDF.

## Conflicts of interest

All contributing authors declare no conflicts of interest.

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