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A CASE STUDY OF REMOTE MONITORING OF HEALTH STATUS OF THE ELDERLY AT HOME IN TAIWAN

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Abstract

This case is a B2B2C model (service provider vs. community vs. the elderly) of innovative tele-care service provision. The service provider under study is the Chu-Shan Show-Chwan Hospital, a district hospital. The community consists of the social welfare institutions such as temples, community care centers, and nursing homes. The elderly are either residents of the community or the nursing homes. The community, as a service promoter, contributes to the increased acceptance compared to the traditional B2C model. Many communities under study and some social welfare organizations are highly interested in providing health care service to the elderly, and will support future operations if the results are satisfactory. Through this project, the district hospital can extend its primary care function to communities, build up trust among people, and improve the physician-patient relationship.

Keywords: Telemedicine, Primary Care, Long-Term Care, Aging in place, Technology acceptance model, Trust

Introduction

Long-Term Care

Long-term care is a prevailing issue in every country due to the aging of population and an increasing number of chronic diseases instances. In particular, the aging index in Taiwan was 58% in 2007, and is projected to reach 100% in 2016. In Taiwan, taking care of the elderly is traditionally done by family members in a social structure dominated by the extended family [1].

Long-term care is usually divided into three types: institutional care, community care, and residential care [2]. The capacity of institutional care can support only 6% of the elderly [3], so most of the elderly wish to be taken care of either at home or in the neighborhood. Family members are thus playing a major role. The percentage of those who need medication care is only about 10% [4], with the other mainly in need of life care, so community care and residential care have been the mainstream long-term care types in Taiwan [4].

Some of the elderly under long-term care suffer from increased morbidity rate or poor prognosis so they need long-term care to survive. The others are too weak due to aging so they cannot take care of themselves. In either case, long-term care should cover the mental and physical health, as well as social life functions [2].

The main characteristics of long-term care include:

1. Target: those in the community who have deficiency in physical, psychological or social adaptation abilities.
2. Scope: preventive, diagnostic, therapeutic, rehabilitative, supportive and maintenance services.
3. Duration: more than 30 days.
4. Place: community or institutional care centers.
5. Objectives: to prevent functional degradation, and to achieve functional independence.

In health care for the middle aged and the elderly, the development of a complete and sound long-term care system is a major help for the normalization of healthcare system, and the inhibition of rising health care costs. The graduate change in social structure makes it necessary to develop a long-term care system to solve the issues faced by the elderly, the family and the society.

This study starts from how the district hospital, in difficult times, managed to construct a telemedicine system in cooperation with community welfare organizations, to extend the primary care function to the elderly in the community, to facilitate the referral process and to reduce waste of health care resources.

Primary Care

Primary care is the patient's first contact with the health care system. As the "gate keeper" of the health care system, primary care provides the general out patient service and preventive services, dealing mainly with initial screening, diagnosis and treatment, and also refer patients who need further treatment to specialized hospitals.

The ultimate goal of primary health care is better health for all. WHO has identified five key elements to achieving that goal [6]:

1. reducing exclusion and social disparities in health (universal coverage reforms);
2. organizing health services around people's needs and expectations (service delivery reforms);
3. integrating health into all sectors (public policy reforms);
4. pursuing collaborative models of policy dialogue (leadership reforms); and
5. increasing stakeholder participation.

The concept of Primary Health Care adopted at the Conference of Alma Ata in 1978 is endorsed by the NPPHCN and forms the basis of the NPPHCN definition of PHC. In 1978, the WHO explained the meaning of PHC as providing accessible and necessary health care to all individuals and families in the community. The WHO also urged all the countries to emphasize PHC [6].

The Nature of Primary Care

1. Excellent primary care is grounded in both the biomedical and the social sciences.

2. Clinical decision making in primary care differs from that in specialty care.

3. Primary care has at its core a sustained personal relationship between patient and clinician.

4. Primary care does not consider mental health separately from physical health.

5. Important opportunities to promote health and prevent disease are intrinsic to primary care practice.

6. Primary care is information intensive [7].

Summarizing the above arguments, we conclude that the primary care needs not only the information and medical technology provided by the district hospital, but also the maintenance of relationship between the elderly. Since the doctors cannot go to the villages to serve the patients everyday, local health care workers are employed to maintain the relationship between the elderly and the hospital. Traditionally, health care providers can reduce the complexity by working with other knowledgeable health care workers [7, 8].

Tele-home care

The content of tele-home care include personal care, general nursing tasks, physical therapy, social work, nutrition and health consultation, meal delivery, patient transportation, emergency help system. The service should be a holistic care that takes into account the life quality of those being cared. Community and home care are promoted by scholars and governments as the main models for aging in place, which can satisfy the needs of most of the care receivers [9, 10].

The target of the tele-home care is the people served by community or residential care. These care receiver who don't need daily medical care, can use wired or wireless communication, coupled with wearable vital sign sensors to construct a bi-directional link with the medical professionals. That will reduce transportation cost and increase the mobility of the care receivers. The health insurance spending is also lower because of early warning enabled by the long-term and immediate information flow, with the potential of transferring institutional care to residential care and becoming an important part of preventive health care. 。

Telemedicine

Telemedicine is defined as any health care provided to patients via technology across a distance[11, 12] Telemedicine can potentially break through barriers of time and distance currently encountered in accessing health care by using technology such as telephones, computers, and interactive video transmission [13, 11, 12]. Advanced communications technology can potentially remove geographic distance as a barrier to provider–patient interaction and information retrieval, thereby providing a more equitable healthcare distribution [11].

Background

Health in Taiwan

National Health Insurance (NHI) has changed the healthcare seeking behavior of the Taiwanese people. NHI covers every citizen and provides a wide range of health care services. The increased accessibility of health care service has boosted the satisfaction of the people [14]. But the convenience and low fare has caused a abnormally high rate of 17 times of out patient services on average, more than twice as many as the number in developed countries [15]. Most of the Taiwanese people prefer to seek health care in large hospitals and medical centers because they believe the service quality is better there. But the excessive number of patients has actually reduced the service quality, which in turn leads to lower cure rate and thus more visits to the hospitals. This vicious cycle has caused waste of the national health care resources and the increasing deficit of the NHI.

Because the NHI did not impose a strict referral system initially, people in Taiwan are not used to it and still have the blind faith that the equipment and doctors in medical centers. The importance of primary care and family physicians is neglected. This has caused the withering of local hospitals and vicious competition between medical service providers. The failure of a referral system has caused the lack of long-term monitoring of patients with chronic diseases. Patients with acute problems also suffer from the lack of a referral system because of repetitive examinations and the increased possibility of complication. In order to build a proper hierarchy of health care, the NHI has established a referral system in 2005 to improve the quality of health care and reduce waste of resources.

The referral system encourages the patient to seek health care service in primary care first, before being referred to hospitals if necessary. In this way, the patient can be referred to proper higher-level medical institutions without repetitive examinations. Larger hospitals can thus focus on patients with more serious problems. Under this referral system, a better cooperation between health care organizations

can be achieved and the waste of medical resources can be reduced so the patient can get better service [16].

   With the progress of medicine and technology, and the increased income, Taiwan had over two million senior citizens aged over 65 in 2007, and the elderly constituted over 10% of the total population. The aging index reached 58.13% [17]. Since the elderly population had exceeded the 7% threshold set by the World Health Organization (WHO), Taiwan had officially become an aging society. The phenomenon of aging society has derived problems such as shortage of medical resources and reduction of quality in healthcare services. To cope with these problems, Taiwan government has actively planned and promoted various telemedicine and long-term care projects in recent years.

   The accelerated aging and the increasing morbidity rate of chronic disease have increased the danger of disease and functional deficiency among the elderly. In a study commissioned by the Department of Health showed that the percentage of the elderly who have at least one deficiency in activity of daily life (ADL) is 9.0% [14]. To accommodate the aging population, an important direction for the government to promote a home-based health care service is a model based on residential and community care, using the information technology combined with health care service to construct a new type of THC service.

Aging in place

Aging in place (getting old in a familiar environment) is a strongly-held faith that is rooted deeply in Taiwanese people's traditional mindset. Especially in rural societies, the people are linked to the land through life-long struggles and cooperation. The sense of place and the identification of the residents are collected [18]. A survey by the Ministry of Interior showed that more than 80% of the elderly wish to live with their children or their spouse, or next door to their children [19]. The fulfillment of aging in place can thus satisfy the need of the elderly [20].

   The western countries have a concept of "successful aging", meaning the individual can adapt to the aging process, stay fit physically, and enjoy his or her own life [21]. The three key indicators of successful aging are [22]:

1. low probability of diseases and disease-related

2. high cognitive and physical functional capacity

3. active engagement of life

   Crowther added the positive spirituality as the fourth factor of successful aging, emphasizing the importance of religious belief in supporting the older adults when facing aging [23]. Summarizing the

above arguments, there four points regarding to long-term health care for the elderly that have to be observed:

1. Make them independent, not just cure their diseases.

2. Integrated: the care provided should include medical, rehabilitative, and social, economical aspects.

3. Continuous: The process of long-term care should be continuous, including an emphasis on prevention than treatment, and not only in-hospital treatment. The form of care provided should also be continuously changed as the physical condition of the patient changes.

4. Resources allocation: It's a waste of medical resources if chronic patients occupy the hospital beds for acute diseases. The invasive examination in the hospital cause by the lack of referral data is also unnecessary. The coordination of different medical organizations can bring proper allocation of resources [24].

   So a local primary care organization should pay more attention to the long-term care of the elderly, to meet the requirements of successful aging.

Theoretical background

Technology acceptance model

The original technology acceptance model suggests that two beliefs – perceived usefulness and perceived ease of use – are instrumental in explaining the variance in users' intentions. Perceived usefulness is the degree to which a person believes that using a particular system will enhance his or her job performance. Perceived ease of use is the degree to which a person believes that using a particular system will be effortless. These determinants are also easy to understand for system developers and can be considered during system requirement analysis and other system development stages. These factors are common in technology-usage settings and can be widely applied to solve the acceptance problem [25].

   Information systems researchers have investigated the technology acceptance model, and found it to be valid in predicting the individual's acceptance of corporate IT systems [26, 27, 28]. Venkatesh and Davis [29] proposed an extension, TAM2, which consisted of social influence processes (subjective norm, voluntarism, and images) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use), but it omitted attitude to use due to weak predictors of either behavioural intention to use or actual system use. In addition, Agarwal and Karahanna [30] have extended the technology acceptance model with constructs such as cognitive absorption, product involvement and perceived

enjoyment.

Trust

Paul and McDaniel [31] examined the relationship between interpersonal trust and virtual collaborative relationship (VCR) performance by studying a telemedicine project. Out of the four types of trust identified, if any one is negative, then it is very likely that VCR performance will not be positive. One way to facilitate trust building was proposed by Stewart [32], who showed that when an unknown target is related to an organization one already trusts, the trust can be transferred to the new target.

In the past, the promotion of tele-care service was based on the technology acceptance model (TAM), concentrating on the ease of use and usefulness. But in Taiwan, the elderly are more conservative and are generally not willing to go to hospitals unless they have to. They are more inclined to stay with their family and not willing to get to nursing houses. The elderly are usually not comfortable with new technology and do not trust the measurement equipment. About 80% of the elderly have not heard of tele-health care (THC), and worry about the difficulty of learning how to use the equipment, how much they have to pay, etc. [33]. The study [34] showed that patients expect THC service to be easy to operate. All these factors contribute to the failure of previous projects using the B2C model. In the past, the promotion of tele-care service was based on the technology acceptance model (TAM), concentrating on the ease of use and usefulness. But in Taiwan, the elderly are more conservative and are generally not willing to go to hospitals unless they have to. They are more confined to their family and not willing to get to.

Community care system operation

The environment for hospitals in Taiwan has been increasingly difficult, with the number of hospitals shrinking from 514 in 1992 to 359 in 2004 [Department of Health]. The health care resources are not fairly distributed to district hospitals, with the audit and payment of the NHI favoring large hospitals. The referral system is not properly enforced so the income of district hospitals is heavily affected. After the 921 earthquake, two sizable hospitals (with more than 100 beds) in Nantou were closed [35].

The project was executed in Nantou County, the only land-locked one in Taiwan. The main economic activity in Nantou is agriculture so the aging problem is more severe than that in the large cities. The common characteristics of the elder population in the rural areas are 1. living alone or only with their spouse and with older age; 2. less educated, without enough knowledge about health care; 3. insufficient in social resource; 4. illness-plagued and

in need of long-term monitoring and care. The communities are closed and the residents are not familiar with preventive health care. The Chushan Township is located in a mountainous area where travel is not very easy. The Show-Chwan Hospital now shoulders the health care responsibility of this area.

In such a difficult environment, the Show-Chwan Hospital needs to build a good relationship with the local residents and extends its function as a primary care organization. By providing the integrated health care to the elderly, the hospital can concert from a district hospital to a long-term care hospital.

By adding the trust transfer factor, the hospital wish to build a B2B2C model of tele-health care service, utilizing the trust to the community to facilitate the acceptance of the vital sign measurement equipment.

The Sheliao Neighborhood, selected to run the pilot project in, has a local religious center, Tzunan Temple, which also serves as a charity. The temple has been working with volunteers to provide emergency relieves and social security, including tuition fee subsidy and free lunch for school children and meal delivery to those in need. Tzunan Temple is also a place for the elderly to meet. The temple had strong interest in participant the local health care programs, so the hospital decided to cooperate with temple.

The three parties involved in this project are described separately below:

1. Service Provider: District Hospital

Chushan Show-Chwan Hospital is the only qualified regional health care center, with 200 general beds, 100 specialized beds, 45 doctors, and 215 nurses. The hospital has been devoted to health care services in remote rural areas, and has been positioned as a community health care service provider. The hospital has penetrated the communities, provided comprehensive health care service, and established warm relationship with the residents. It also combined with the community resources to elevate the quality of health and life of the local people.

2. Community: religion center

Tzunan Temple, as a service provider, is playing the role of gap-filling by concentrating in the services the government is not able or not willing to provide, but the people actually need [36]

The Han communities in Taiwan are typically shaped by the immigrant origin. Mass immigration from China around the turn of the Ming and Ching dynasties resulted in a society with hardship of leaving their homeland and fear of the unpredictable future. Religious faith became the spiritual support of the people, and many of them built temples which

turned into the community center of settlements, "a cultural nexus of power" [37]. Temples can be found in every corner of Taiwan, as they have been associated with the destiny of the land and the people, and became a symbol of geographical and ancestral relationship, linking the people to where they had come from. Through the public rituals of religion, the community identification is intensified, and the people are more united under the same faith [38].

In the wake of modernization, religious activity is one of the few opportunities that are compatible with the social structure and residential identification for the people to recognize the community as a concrete existence. The local temples can satisfy the spiritual, social, psychological and entertainment needs of the people, linking the people with the community both in mentality and history. As a concrete symbol of the community, the temple forms a center of everyday social events and also a spiritual support when people are suffering from disasters and diseases [39].

Tzunan Temple is a popular land god temple and a local religious center that has brought prosperity to the neighbourhood and also served the community as a charity organization. The community is now facing a population aging issue as the young have moved to the big cities for a living. A tele-health care system that incorporates identification technology can send the biometric parameters, such as blood pressure, oxygen saturation, blood glucose level, etc. to Show-Chwan Hospital to be monitored. Abnormal data will trigger an alert that's sent to the elderly and their family via short messages, so that an early response can be activated, and the quality of health care service can be improved. In the planning stage, a total of 214 elderly residents were registered to receive the health care service in this project.

3. Community tele-care system:
The equipment, function and location of the system components are listed in Table 1.

(1) The user end (Tzunan Temple Community Center): vital sign monitoring equipment was installed. The equipment was linked to the hospital end, and had a simple user interface and alerting and emergency help function.

(2) The hospital end has the following functions:

A. Remote information access function: The vital sign readings can be uploaded to a database at any time. The database can be accessed remotely for the physician to retrieve historical and latest data for analysis and diagnosis.

B. The user interface should have the following functions:

(a). configurable in the analysis and notification

of abnormal readings.

(b). capable for managing, editing, and sending short messages and emails about the person being monitored.

(c). capable of replying the query from the person being monitored.

(d). personal data management.

C. Tele-care system usage and query interface

(a). The family members of a Id card holder can use the Id number to login the system and query the status of the card holder.

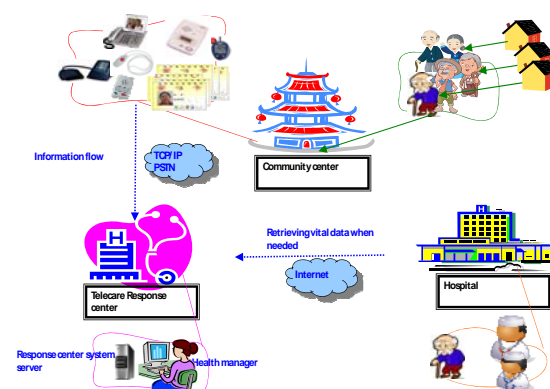(b). The health manager can login and query the data to be examined.

Fig 1: Community tele-care system

Figure 1 shows the community care system: the religious center is a place the elderly often visit. The identification can be done with the Id card made for this project, or the NHI card. The measurement equipment comes with user-friendly touch-screen interface, for the elderly to operate by themselves. For those who still cannot operate the system by themselves, Tzunan Temple sponsored medical personnel from Show-Chwan Hospital to help them and to provide health education。

The vital signs measured are encrypted and sent to a database located at the Show-Chwan Hospital, and screened automatically for abnormal data. The health manager will be notified if there's any abnormal data observed, and contact the subject to discuss the health status. The interaction between the health manager and the community residents builds up a good relationship between the hospital and the residents, reducing the information disparity and encouraging the residents to care more about their own health. The health manager's response to abnormal data includes sending short message to family members and family physicians to help the elderly seek further medical service.
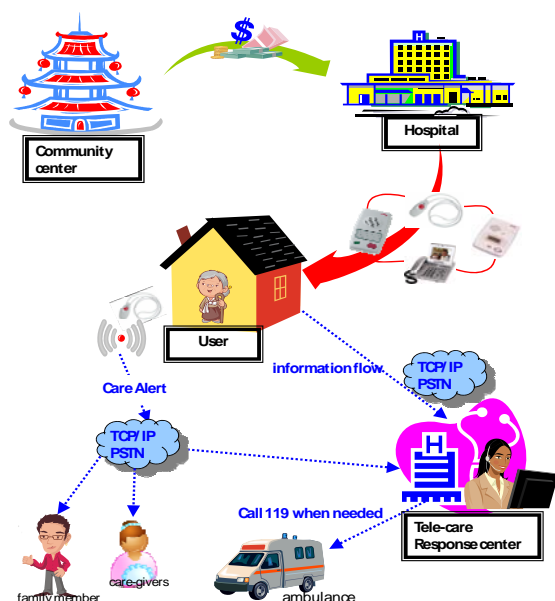
4. Emergency help system:

Fig 2: Emergency help system

An easy-to-use emergency help system was deployed to 50 homes with special need, at the expense of Tzunan Temple. It consisted of a central response unit and residential units. The residential unit can send a signal to the central unit when a wearable button is pressed within 50 m of a receiver connected to telephone line. The central unit will notify the health manager and send short messages to family members and other people who can help the elderly when there is a emergent situation. The receiver is also equipped with a video telephone so that the health manager can better communicate with the elderly to discuss immediate treatment and next steps.

The mother of the chairman of the administration committee of Tzunan Temple, aged 80, was one of the the elderly participating in this project. The high social status of this lady, along with the subsidy from Tzunan Temple, and the volunteers helping the elderly in the temple, contributed to the success of the pilot project. This is one evidence that trust transfer can facilitate the acceptance of high-tech measurement equipment.

The cost of the vital sign monitoring equipment has been a huge burden for the hospital or the household. The elderly residents in mountainous areas belong mostly to low-income households that are subsidized by the government of charities.

The community charity considers this to be their responsibility and donated the equipment to 50 patients with cardiovascular diseases.

Figure 2 shows that the vital signs such as the body weight, temperature, blood pressure, blood glucose level, are send via the telephone line to database in the tele-care center for further management and analysis. The hospital can retrieve the data or when the patient is referred to another medical organization, the long-term data can also be retrieved there as a reference for diagnosis.

Family members or care-givers can query the health data via the Internet. If the software program detects abnormal readings, the health manager in the tele-care center will proactively contact the user by video telephone. The response center is staffed around the clock to respond to all incoming messages. The handling of the incoming is also recorded for later analysis.

Emergency help system: the use can press a button when immediate help is needed. A signal will be sent to family members or care-givers and the tele-care center. The tele-care center will call 119or the hospital to help the user. The destination to be called can be set in the system and will be called repetitively until answered. Short message or email can also be used to send the alert to family members or friends of the user.

5. Data
The measurement data, chronic disease control and emergency help cases recorded during the execution period of the project are listed in Table 2.

Benefit and implication
Besides the increased acceptance of vital sign measurement equipment, we have seen several other intangible benefits:

1. District hospitals in the Chushan area were caught between the local clinic and the Taichung Veterans General Hospital because people would skip the district hospitals when they sought medical help that cannot be provided by the local clinics. After the project under study started, the elderly in local elderly people started to feel the care from the Show-Chwan Hospital and the community, and have more confidence towards the hospital. The long-term data are now stored in the database in the hospital, so the hospital can get a better picture of the overall health status of the patients, and thus provide a better service. This project has successfully raised the number of patients visiting the hospital and resulted in better medical resource allocation.

2. This project has set an example of integrated community care system built upon trust and mutual understanding. The success of this project has attracted the industry and charity organizations from around the country to assimilate this new model of community care. The exposure in the national media not only raised the image of the hospital, but also the donation to Tzunan Temple.

3. The health of the elderly is now under better management with the volunteers not only helping them with the use of the measurement equipment, but also general issues related to health care. For example, they got advice on which department in the

hospital they should visit, or how to make reservations. The complaints and criticism about the hospital has decreased and satisfaction and reputation raised. Tzunan Temple is also please to see the combination of the hospital and the community which has made it easier to provide more service to the community.

4. The supplemental value of the hospital has increased: this project helps the elderly to extend their healthy condition, and the preventive alert system can reduce further health insurance expense and minimize the waste of medical resources.

5. This project has redefined the service model of long-term care for the elderly with a remotely accessible database of the vital signs measurement data, and close interaction between the patient and the health manager. When abnormal cases do arise, the health manager can provide suitable advises and arrangement for further medical services. The focus has shifted from treating diseases to health care and preventive medical service. This new model not only provides a new direction for Show-Chwan Hospital, but also can boost the development of relevant products and services.

Limitation of this study and future development

This project has resulted in abundant fruits. In the same way that trust, as social factor that affects the adoption of new technology, the social psychological requirement is also a very important part of the overall health of the elderly. For example, those who live alone and have less interaction with others might need more community involvement. After all, no technology can replace the real meaning and value of humanity.

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Table 1: Tele-care data of Community Center (n=1022 instances) duration 9710-9803

Quantitative item	N	Description
Number of subjects	214	1. vital signs measured in the Tzunan Temple community center 2. Total instances of measurements=1022, among which 6 were handled by the health manager, and being treated in Show-Chwan Hospital under continuous monitoring.
		<table><tr><td>measurement item</td><td>number of abnormal cases</td></tr><tr><td>●blood pressure</td><td>402</td></tr><tr><td>●blood glucose level</td><td>68</td></tr><tr><td>●pulse</td><td>75</td></tr><tr><td>●oxygen saturation</td><td>4</td></tr></table>
Number of households with home safety care	50	1. Accident and emergency notification. 2. Ambulance calls. 3. Emergent message dispatching. 4. Routine communication with 50 households every Wednesday or Thursday, including health education.
Control of abrupt changes in chronic disease	3	Patient 1: blood pressure remained high after taking medicine. Beside health education, the patient was referred to the hospital for out patient treatment and monitored regularly. Now the condition has returned to normal. Patient 2: Blood pressure remained high after several measurements. The patient was reluctant to see a doctor until repetitive health education and persuasion. The family doctor called and the patient has since accepted treatment and the condition has improved. Patient 3: Diabetes originally treated with injective insulin, but changed to oral medicine recently. Abnormal blood glucose level observed on 2008-11-21, and the patient was advised to see a doctor. After changing back to injective treatment, the condition is now under control.

		Patient 5: Centipede bites reported on 2008-10-05. The health manager advised the patient to use ice pack therapy and seek emergency room treatment. The health manager called the patient twice afterwards and confirmed that the patient was well without further medication.
Emergency help	11	Patient 6: Angina pectoris reported on 2008-11-11. The health manager judged it to be myocardial infarction and called an ambulance to send the patient to Taichung Veterans General Hospital for emergency treatment. The health manager learned from the hospital that the patient was in ICU the next day. The patient was discharged on 11-15 and returned to normal life, but still being monitored with the tele-home care system.
		Patient 8: The emergency button was pressed accidentally when the patient fell. The health manager called and queried if there's any injury. Health education about how to deal with falls was given. No abnormal symptoms reported during continuous monitoring afterwards.
		Patient 11: fainted because of low blood pressure on 2009-03-25. After treatment in the ER, the patient returned home on the next day. No abnormal symptoms reported during continuous monitoring afterwards.
Number of visits to the doctor	243/month	

Table 2: Tele-health care system (component)

Equipment name	Quantity	Function	Location
Sphygmomanometer	1	Blood pressure monitor, useable on patients with heart diseases	Tzunan Temple (Community tele-health care center)
Blood glucose meter	1	For the residents to measure blood glucose level	
Id card	21	An inductive card for the system to identify individuals	

	4		
Id card reader	1	To read the Id card	
Multiple biometric meter	1	For the residents to measure 4 biometric parameters, with a touch screen for the elderly to use.	
T400 and Amine button	50	Alarm system to ask for immediate help from up to 12 parties, such as the tele-care center, the health manager, family members, the hospital, and 119	Homes of 50 high-risk patients with cardiovascular diseases.
Emergency call and security video monitor	50	Accident and emergency notification, ambulance and emergency communication	
Video phones	50	To communicate with the health manger over the telephone line	
Response center system server	1	To record the data collected from the residents	Chushan Show-Chwan Hospital Response center