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Storm surge prediction with management information systems: A case study of estimating value and observations system

C. Y. Chen · T. H. Chen · Y. H. Chen · S. E. Yu · P. Y. Chung

Abstract A natural disaster is a major adverse event resulting from the earth's natural forces. We can now take advantage of information technology (IT) devices to make migration decisions and hazard analysis. The range of IT applications is very wide, and could include robot manufacturing, remote exploration, fuzzy Lyapunov techniques, artificial intelligence, intelligent devices, tension leg platform design, consumer and service quality, and management information systems. Management information systems are especially helpful to medical personnel when carrying out the treatment and medication of patients. Sometimes, though, hospital staff might not have immediate access to a patient's records such as response to treatments, medication status, or examination results because the computer equipment is not easily portable. In such situations, it is only possible to keep written records, with the data being cataloged or referred to only after returning to the nursing station or office. If the hospital could implement a computerized medical service cart for use in the wards, the above problems would be solved. These computers could use a wireless network system, linked with the central server to access information. The

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technology now exists and the era of the smart phone has now been entered. Smart phones/tablet PCs could be applied for clinical medical care. For the elderly and patients with chronic diseases, smart health devices designed for home care service are necessary and should be applied as soon as possible. This study designs a wireless physiology signal monitoring system that uses a smart phone with a wireless network apparatus to provide convenient monitoring for patients in the home care service system. The wireless care system is designed for patients who need long-term home care services or assistance with chronic diseases. This paper provides important suggestions to develop ways to connect patients to medical care institutions through the internet.

Keywords Natural disasters · Migration decisions · Hazard perception · Balance chains · Safety net

1 Introduction

The development of science and technology has led to improvements in CPU, computer hardware, and popularization of 3G networks. Smart phones are becoming increasingly popular in the market. With progress in the quality of medical care, improvement of surroundings and sanitation, and advances in medical science, as well as health and public welfare, people are living much longer than ever before. The number of the aging individuals is increasing, while the birthrate is seriously decreasing. The graying of the population is becoming more and more obvious (Bajo and Umgiesser 2010).

At the same time, natural hazards, such as floods, earthquakes, and tsunamis, happen more frequently every year all around the world. In recent years, due to a lack of mobility, there have been a lot of patients, especially the elderly, who have not had the opportunity to flee when natural disasters occur. Therefore, an aging society brings about some related problems. Home care services for patients with chronic diseases should not be neglected anywhere in the world. The development of rescue robots to help deal with natural hazards caused by humans has been studied (Abbas and Othman 2012; Abd-Alla et al. 2011; Chang et al. 2012a, b, c, d, e), as has the establishment of a system that supports real-time changes in the operation mode of the robot between remote and autonomous operation (Chen et al. 2012a, b, c, d, e; Chen 2004, 2006a, b, 2007a, b, c, 2008, 2009a, b, c, 2010a, b, c, d, e, 2011a, b, c, d, 2012a, b, c, d, e, f, g, h, i, j; Chen et al. 2012a, b, c, d, e, f, g, h, i). Hence, establishing home care services and long-distance medical systems utilizing the smart phone is an urgent need (Shih et al. 2011, 2012a, b, c, d, e, f, g, h, i, j, k, l, m, n; Shih et al. 2010, 2011, 2012).

Traditionally, medical care apparatus requires an expensive host, a complicated power source, and groups of data transmission circuits. In the future, doctors can use smart phone physiology signals transmission systems to obtain more data. Then, after analysis, they can make an initial diagnose of the patient's condition. Patients with chronic diseases will not need to remain in pain waiting for telephone ines to become free; instead, patients in a care space can move freely within the coverage of wireless signals.

2 Literature reviews

With the production of smart phones and the universality of the 3G network, the growth rate of smart phones is rising (Fig. 1). With smart phones, not only users can have

information in hand but business people can also send and receive e-mails, hold video conferences, and check stocks and world news. With built-in abundant multimedia, cyberpunks playing online games, watching online TV (such as Youtube and Dailymotion), and surfing social networking sites (such as Facebook, Twitter and Msn) enjoy life's amusement on the go. That is, tasks handled by computers are changing to operate through mobile devices (Chen 2005a, b, 2006a, b, 2007a, b, c, d, e, f, g, 2008a, b, 2009a, b, 2010a, b, c, d, 2011a, b, c, 2012a, b, c, d, e, f, g, h, i, j, k, l; Chen et al. 2012a, b, c, d, e, f, g, h, i, j; Chen et al. 2008, 2009, 2011a, b; Tseng 2011, 2012a, b, c, d; Yang 2008a, b, 2012; Yeh et al. 2008, 2012; Yeh and Chen 2010; Yu 2011a, b; Zhang et al. 2011a, b, c, d; Zhao 2011a, b; Zhu et al. 2011; Zou et al. 2012; Liu 2011, 2012).

According to population and household censuses provided by the Taiwanese Ministry of Interior in 2011, the elderly in Taiwan in 1993 amounted to 7.09 % of the National Total Population. Taiwan is officially becoming an aging population society, and its aging population is growing. Up to September 2011, the total population was 23,197,947 of which 10.81 % were over 65 years of age. In a report of the Taiwanese Council for Economic Planning and Development in 2011, population trends demonstrate this aging. In 2010, the number of people over 65 years old was 2,471,000. The report predicts this number to reach 2,831,000 around 2014, with the number continuing to rise speedily. Around 2041, the number reaches 7,029,000; in 2056, it will become 7,616,000, or approximately 3 times the current total. The elderly population represented 10.75 % of the total in 2011, which will increase to 14.0 % in 2017. We live in an aging society as reported by international institutions. In 2025, it will be 20.1 % and we will enter a super-aged society. In 2060, the population of people over 65 years old will reach 42 % (Fig. 2).

With the coming of the aging society and the augmentation of the incidence of chronic diseases, the requirements for medical care and long-term care services increase rgeatly. Because of the above-mentioned society trend, the elderly and patients with chronic diseases must live independently and take care of themselves (Chen 2008; Chiementin et al. 2012; Cheng 2011; Chiang and Wang 2011; Chiang 2010; Chiou 2011; Cigada et al. 2012; Ho 2010; Hsiao 2005a, b, c, d; Hsieh 2006; Hsu 2012; Hsu et al. 2011, 2012a, b, c, d;
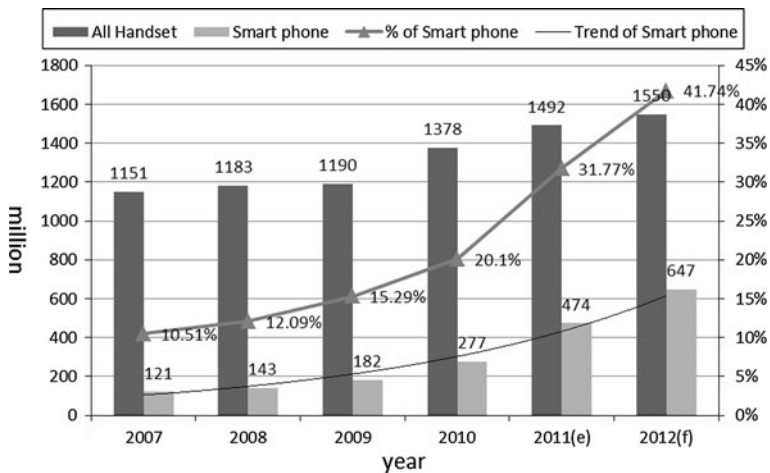

Fig. 1 Estimates of shipments and growth rates in smart phones from 2007 to 2012
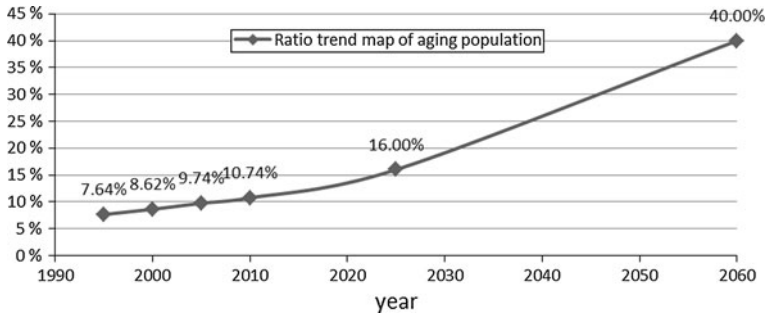
Fig. 2 Trend map of aging population in Taiwan

Manna 2012; Shen 2011; Soundarrajan and Sumathi 2011, 2012; Su 2011; Tang 2011; Tsai 2008, 2010, 2011a, b). The products and services needed for the care of and communication with the elderly and patients with chronic diseases will become more and more important. From the point of view of life companionship, it can meet the needs of life management and entertainment for the elderly and patients with chronic diseases. Not only will they not bother with their families but they can also resolve other people's difficult problems. Hence, the development of smart phones for an aging population society is becoming important.

Nowadays, almost everyone has a cell phone. There is a trend to use a smart phone as the device of mobile health care applied in home care services. 2G cell phone dealers have developed the older cell phones exclusively for senior citizens. A cell phone has entered the era of a smart phone. Smart phone/tablet PCs are mainly applied in clinical medical care (Lin et al. 2012; Lin 2011, 2012a, b, c, d; Lin 2009, 2010, 2011a, b, 2012a, b). A smart health machine designed to monitor health and safety for the elderly and patients with chronic diseases is gradually being taken seriously. The majority of families cannot afford foreign servants to take care of the elderly or patients with chronic diseases who must stay at home alone in the daytime due to economic factors or situations. However, it is an difficult decision. If a smart phone with home care services is developed to monitor the elderly and patients with chronic diseases, family members can be relieved of this problem (Liu 2012; Liu 2009, 2011, 2012a, b, c, d; Macha et al. 2012; Mahmoud 2012).

With smart phone physiology monitoring signals, the elderly and patients with chronic diseases don't tolerate toil of going a hospital and back. It not only saves time but also reduces medical care resources. Undoubtedly, it is beneficial for the whole national economy.

The basic outfits of smart health machines are dialed calls, a camera, and health monitoring. Other newfangled functions that the young love are not needed since they will decrease the amount of available memory (Inoue et al. 2012; Jiang et al. 2012; Kuo 2010, 2011a, b, 2012a, b).

This paper proposes that smart phones equipped with wireless network devices to execute wireless physiology signal monitoring systems should provide a convenience to patients in their movement within the home care service system (Huang 2012; Lee 2010a, b, 2012a, b; Li et al. 2012). Utilizing a smart phone to build a smart home, a wireless care system which is barrier-free can be created which will allow patients requiring long-term home care services or with chronic diseases be taken care of at home (Fig. 3).

Fig. 3 Intersection of hospital,
person, and home
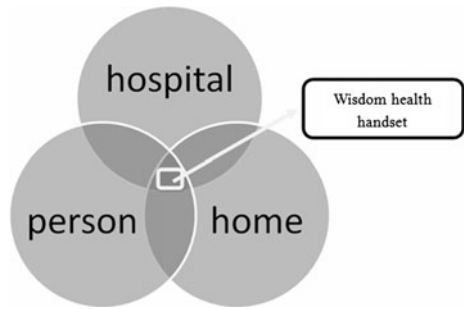
3 Clinical application

Being portable, smart phones can surf the internet by Wi-Fi and install/delete application programs. Its progressive hardware can be compared with a desk-top computer. Therefore, a number of developmental factories are starting to develop hardware and software concerned with medicine and applied in smart phones. Many hospitals around the world have been utilizing such clinical applications.

3.1 Application of e-book

Since the tablet PC entered the market, relevant medical care e-books have started selling. Some e-books with application interfaces have become easier to search and read relevant information and films. Relevant e-books, on, for example, dissection, physiology, pharmacopoeia, and surgical operations, can be bought by people engaged in medical care in order to search for information and to give patients some medical education.

3.2 Reference of anamnesis

Surfing by Wi-Fi or cell phone, people engaged in medical care on the go can use a smart phone to connect with a cloud database built by hospitals to immediately acquire patients' anamnesis and relevant results of physical examinations.They will not have to waste time going to a day care centre or a clinic any more.

3.3 Clinical application in domestic and international hospitals in

The Washington D.C. Veterans Affairs Medical Center have applied a smart phone in first aid for heart disease. The Trillium Health Center in Canada has established a Blackberry Enterprise Solution in their intensive care unit. All clinical physicians are fitted out with Blackberry smart phones in order to recognise and control their patients' condition directly and to provide medical care services promptly. Clinical physicians in the division of cardiology in the University of Southern California (USC) utilize Blackberry smart phones to search for relevant information and the latest medical knowledge in medical databases, and to manage patients' prescriptions. Applying an e-system, medical care records not only become detailed, accurate and authentic to reduce the incidences of mistakes but also improve the efficiency of the physicians' medical care allowing patients to acquire more qualified medical care services.

4 Distance home care services market

In response to the trend of the aging society around the world and the variation of chronic disease patterns, applications of information and communications technologies in preventive health care, health care, and medical diagnosis are becoming more and more popular. Communications technologies and multimedia apparatus are being utilized to solve the barrier of distance which causes difficulties in medical care service. No matter how long the distance, health care personnel can interact with patients to achieve the purpose of giving treatment and taking care.

Globally, the distance medical care market is very popular. Not only has the Western market developed vigorously but also the growth rates of markets in Asia-Pacific, the Middle East and Africa are constantly increasing. For example, China and India are anticipated to have the highest growth rates in global distance medical care market. The Western market was 2,575,000 dollars in 2007 and 3,908,000 dollars in 2010, with 7,372,000 dollars expected in 2014. The Compound Annual Growth Rate (CAGR) is 25 % (Fig. 4) from 2007 to 2014. The estimated global market capitalization of Frost and Sullivan is forecast to grow from 30 hundred million dollars in 2007 to 124.7 hundred million dollars in 2017; CAGR is 16.8 % from 2007 to 2017. In 2010, global medical materials markets became 5.4 %, and 2,362 hundred million dollars. The medical electronic market (included fitness and health devices) became 10 % and 1,286 hundred million dollars. It is estimated to reach 1,911 hundred million dollars in 2015; yearly compound growth rate is 8 % from 2009 to 2015 (Fig. 5). The distance medical care home care services market in the medical care industry is the smallest of these growing fields and is expected to reach over 20 % growth rate in 2025.

There are six kinds of distance health home care services classified by function: Hospital Information Systems, Electronic Health Records, Personal Health Record, Picture Archiving, Communication Systems, and Mobile Health. The development of any product emphasizes that it should be convenient, miniature, portable, and powerful.

The problems of this industry are to improve the efficiency of taking care and reducing the cost of medical care. Its goals are (1) health managements: prevention, a physical examination and management service; (2) home care services: cure management and home care; and (3) medical care: peracute medical care and chronic medical care. It requires reaching sound diagnoses in early phases and a preventative health system, chronic disease management, and care of the elderly (Fig. 6).
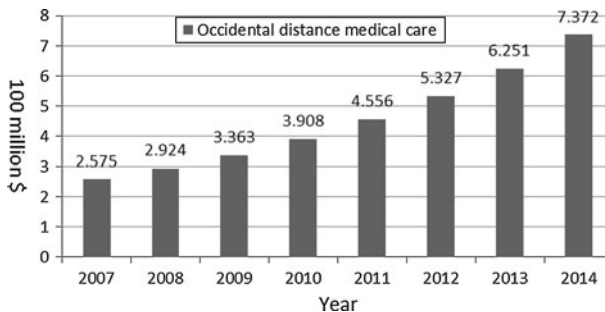

Fig. 4 Market prediction of Western distance medical care from 2007 to 2014
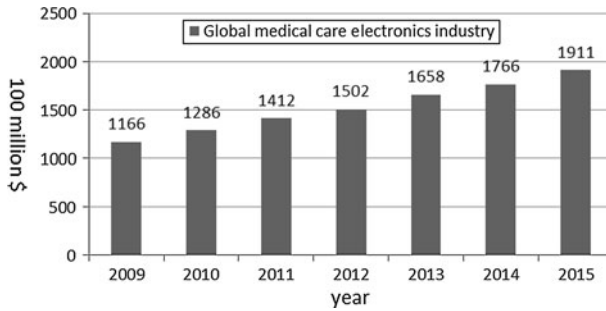
Fig. 5 Market prediction of global medical care electronics industry from 2009 to 2015
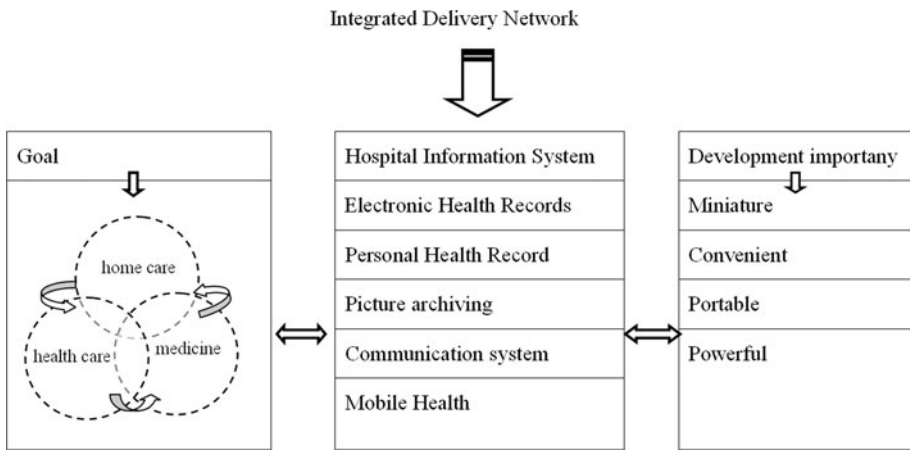

Fig. 6 Relationship of goal, Hospital Information Systems and Development Importance

5 Transmission devices

With the development of wireless communication technology, the requirement for data transmission is diversification. Under the framework of Wi-Fi, devices with discriminating and Radio Frequency Identification (RFID) with tracing and searching by wireless means that all kinds of physiology monitoring apparatus can connect with the Internet by wireless technology. The market range of smart phones in emerging countries are extending widely. Wireless Fidelity (Wi-Fi), Global Positioning System (GPS), Near Field Communication (NFC) and Bluetooth 4.0 arte now built-in standards in smart phones.

The framework of cross-platform data transmission and emergency rescues should possess a Web interface, e-mail and cell phone to provide an instantaneous channel for taking care of and informing relatives, care givers and medical care service centers.

5.1 Principles of design

The system of "smart health machines" developed here employs a modified smart phone (Fig. 3). The first step is to plan a circuit diagram-strengthening module and create new functions according to an individual's needs. The second step is to prepare a suitable-sized

module based on the needs of a circuit diagram to plan an effective distribution of circuits. The third step is to develop software utilizing the ios office system and Object C. The fourth step is to install an infrared sensor, a temperature sensor, Zigbee, sound recorder, and a weight meter in a smart phone. The more value-added services that are added to a smart phone, the more satisfied will be the needs set out in this paper (Fig. 7).

5.2 Derived physiology information

Sensors in cell phones can measure temperature, heartbeat, breathing, and blood pressure, and acquire physiology parameters of electrocardiogram, oximetry measurement, basic pulmonary functions, blood sugar, heart sounds and body fat in the elderly and patients with chronic diseases . Waveforms like electrocardiogram (ECG), electroencephalography (EEG), electromyography (EMG) and QRS waves transmit instantaneously. Developing disease factors like pulmonary functions, diabetes, cholesterol and cancer can be retrieved effectively, transmit correctly, store flawlessly, and be utilized and monitored. Users' physiology information monitored on the go will transmit to hospitals. With these data of useful physiological information transmitted, physicians can diagnose and clinic personnel can treat as soon as possible. Applying PDA/cell phones, users can build a database of the whole treatment or health conditions. It shows instantaneous ECG to make users realize their body conditions easily. Monitors can also check their physiological measurement values and history records on the Internet immediately. As the physiological information measured from users of this system exceeds normal setting ranges, like rapid heartbeat or high blood pressure, it will give a warning to users and monitors. This system can also send short messages and e-mails to monitors' cell phones to make users and monitors become aware of users' body conditions in order to treat any discomfort conditions appropriately or to ask someone to come to the rescue.
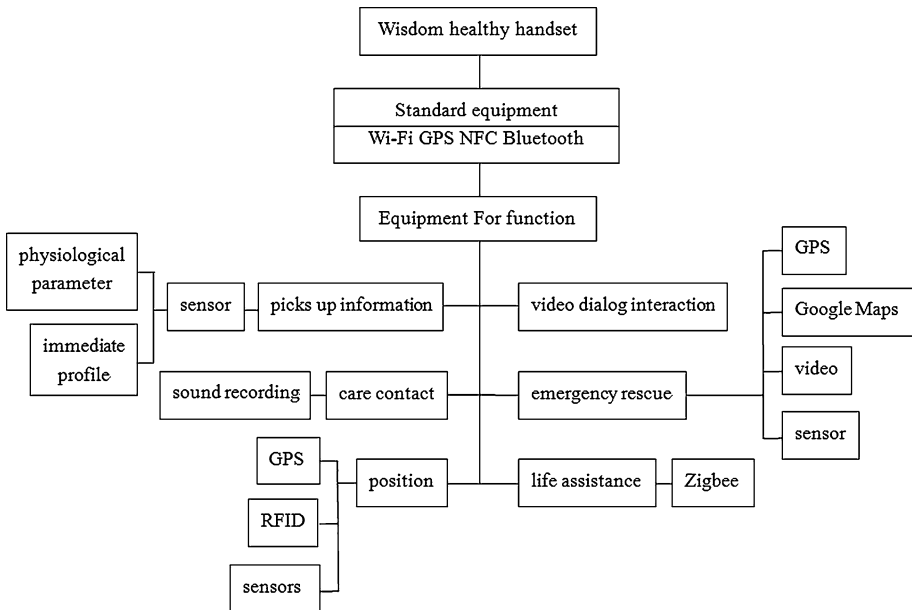

Fig. 7 Structure chart of smart health machine

5.3 Interaction

Most of the elderly and patients with chronic diseases are willing to wait and line up in hospital to "see a doctor". Psychological satisfaction is greater than essential diagnosis. Through digital cameras, clinic personnel can interact with charges to provide health consultations or care services. This not only psychologically satisfies the interaction needs of patients but also reduces consumption of health resources and infection rates in hospitals. A healthy life needs interpersonal interaction and social intercourse. Relatives and friends in the role of monitors can communicate with their charges by digital cameras to demonstrate their care. Family members living in distant places can also observe and recognize the living conditions of people living on their own. Likewise, dependency and anxiety of the elderly and patients with chronic diseases can be satisfied. That is, it can be a media of family love to decrease the psychological stress of the elderly and patients with chronic diseases.

5.4 Connection in medical care service

The system can actively remind the elderly and patients with chronic diseases to wake up, take medicine on schedule, and pass information back to the clinic for medical treatment using a smart phone. In addition, children and nurses can transcribe reminding messages.

5.5 Emergency rescue service

The processes of executing emergency rescue services are (1) integrating the smart phone or GPS (Global Positioning System) with Google Maps, (2) simulating an outside stroll surrounded by a web interface, and (3) reducing distances, calculated by a pedometer, and relate users' actual to users' virtual position. The result will present in Google Maps. Environments and daily home actions or behaviors will be monitored and observed unceasingly by sensors. As soon as behavior models or habits are found to have changed, unusual signs will be discovered. If charges' action signs are not detected for a long time, emergency rescue signals will be sent out. This will improve the safety of home life for the elderly living alone. Moreover, according to the variation in acceleration values, an indistinct rule database will be created. It will use the falling-down module to recognize whether users have fallen. If this has happened, the system will send out warning messages to clinic personnel and monitors, who can then quickly implement a rescue.

5.6 Position

Though the SMS (Short Message Service) mechanism, this system collates GPS (Geographical Positioning System) and RFID (Radio-Frequency Identification) to actively search for users' position. In home care services, LBS (Location Based Services) employ all kinds of sensors installed inside the home. Therefore, users at home will be detected by their behaviors and positions. Administering the above-mentioned function to the elderly and patients with chronic diseases at home might reach the purpose of taking care instantaneously.

5.7 Life assistance

All kinds of life applications, like gas leaks, doors and windows locked after going out, and fire prevention, can employed Zigbee sensing networks. For instance, they can determine the presence of items likely to cause collisions or falls in order to warn the elderly and

patients with chronic diseases in advance. As well as producing alarms, they can start to film and connect with monitors.

6 Discussion

The advantages of smart health machines are in enhancing safety and quality of care, providing health management and preventive medicine, reducing overuse behavior of medical care resources, and promoting home care services. If a smart home is established and applied in all families, human beings will have a more wonderful life (Fig. 8).

6.1 Enhance safety and quality of care

Being familiar with their home environment and living independently, the elderly and patients with chronic diseases will utilize smart phone services, such as emergency alerts at home, emergency rescue system liaison and home safety services. Those services can avoid delay in taking medical treatment, or speed up making emergency rescues.

6.2 Provide health management and preventive medicine

Medical care services include prevention, diagnosis, treatment, rehabilitation, support-ability and maintainability. Home care services give priority to the elderly and patients with chronic diseases. Home doctors usually utilize simple apparatus to carry out examinations on patients. They cannot get the whole result of their examination. In addition, general care-givers are family members only providing clinical conditions and signs of the patients. Utilizing physiological information monitoring, individual health information can be uploaded periodically. Physicians will assess the patients' health from these data. Hence, effective retrieving, correct transmission, flawless storage, and standard monitoring are necessary. It not only reduces overuse of medical care resources but also collects more complete individual physiological information to achieve the purpose of continually detecting and observing health conditions. Before the charges' health conditions deteriorate, their medical group can treat pertinently.

6.3 Improve overuse behavior of medical care resources

The elderly and patients with chronic diseases do not need physically to seek medical advice thereby reducing infection probabilities in big hospitals. Transferring their

Fig. 8 Relationships of person, home, hospital, and wisdom health handset
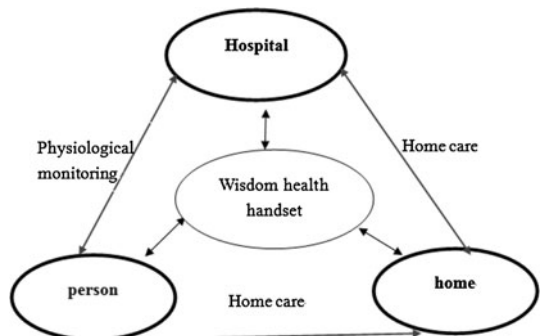
physiological and life information by a smart phone, they can be taken care of at home without the obstacles of space and time. Not only long-term care service costs can be saved but also National Health Insurance can be a lesser expense.

6.4 Promote home care services

Through an instantaneous transmissible message system, professional medical people can interact with the elderly and patients with chronic diseases by video and telephone to diagnose their health conditions and to control the medical care service. Overcoming obstacles of space and time, the elderly and patients with chronic diseases who live in faraway areas and off-shore islands can be provided with medical care services and so improve their care quality.

7 Concluding remarks

Because of advanced technologies and notions of medical care, a smart phone breaks the traditional limits of medical care. It provides medical care services and information to create an instantaneous, safe and efficient medical care market. The development of mobile health care is unlimited (Ahmadian and Azizi 2011; Chen et al. 2012k). The growth rate of users using a smart phone to carry out mobile health care is increasing.

With the coming of an aging population society and the popularization of health care, the mobile health care market and related industries are buoyant. Whether from the view of employees engaged in medical care or of their patients, mobile health care drives a lot of innovative services and applications equipped with other modernized technologies, like WLAN, 3G mobile communication, Wi-Fi, Wimax, Zigbee, and so on. Mature wireless communication technology includes the lighter and smarter mobile information devices, like tablet PC, cell phone, PDA, and iPad. After these essential technologies are perfected, mobile health care will be more complete.

Since the merits of smart phones are portability and ubiquitous and permanent connection with the Internet, users can manage their records of taking medical treatment and prescriptions by themselves. They convey measured data to a hospital by wireless network, Wi-Fi, 3G, and 3.5G to allow physicians to consult and diagnose. Integrating medical care services with wireless communication and family life, patients with chronic diseases can be traced and their conditions monitored. The elderly and patients with chronic diseases can enjoy medical care services and resources any time anywhere through all kinds of mobile communication technologies and devices.

However, the elderly may usually reject rather accept a smart health machine. To make everyone readily accept a smart health machine, its operation interface must be simple, user-friendly and easy to see. By pressing just a few buttons, basic care can be taken of users. Certainly, its price will be so cheap that it will be easily popularized in society. If it is applied in all households to establish smart homes, it must provide a more wonderful quality of life for people.

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