International Journal of Smart Home
Vol.10, No.12 (2016), pp.221-230
http://dx.doi.org/10.14257/ijsh.2016.10.12.21

A Study on the Analysis of U-healthcare in Smart Homes

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Abstract

Healthcare is the one of the most concerned regions in our everyday life. U-healthcare is one aspect of healthcare that is pushing the limits of how to acquire, transport, store, process, and secure the raw and processed data to deliver meaningful results, U-health offers the ability for remote individuals to participate in the health care value matrix, which may not have been possible in the past. In this paper, we examine the U-healthcare industry. In our works, U-healthcare transition was included. We described actual cases, analysis and applicability of current U-healthcare.

Keywords*: ICT, Ubiquitous, Healthcare, Usage.*

1. Introduction

"Ubiquitous" is Latin, meaning existing simultaneously anytime, anywhere. It actually means the environment and space receiving services, while a user is online in the network using anything, anytime, anywhere [1]. The big proposition is that a chip exists in everything. As all things such as books, beds, chairs, boilers, vehicles, refrigerators and lights have design, "ubiquitous" system lets all things have chips. A chip-embedded thing becomes a computer, and humans live with computers. From the information and communications perspective, a "ubiquitous" system is creating a new paradigm on all social fields. The fields are not some specific fields, but all fields in existing society are encompassed. It will be similar in all fields in consideration of the time when computers apply to all fields.

Thanks to recent ICT development, Korea has secured more excellent high-speed communications network infrastructure than any other countries in the world. In addition, the convergence of digital devices, wireless communications technology development, the advent of small and portable various bio signal measuring sensors predict the ubiquitous healthcare (U-healthcare) era, when one can monitor one's own health status, and receive individually customized healthcare service anytime, anywhere [2].

In the ideal future society, where the U-healthcare era is perfectly established, individuals do not have to recognize medical service. That is, U-healthcare itself monitors individual's health status in real time, and automatically takes action at the proper time required for treatment and care. Therefore, individuals cannot only maintain the best physical condition, but receive far more convenient medical service [3][4].

To cope with well-being that can be the foremost interest of modern people, and the upcoming aging society, the current medical service level or format is inappropriate. Now is the time that more advanced medical care service, focused on care and prevention, is needed. U-healthcare refers to healthcare and medical care

ISSN: 1975-4094 IJSH

service offered by collecting, handling, delivering and managing human health information through the combination of ubiquitous computing concept from ICT with the health and medical care industry [2][5][6]. Figure 1 below shows a 'U-healthcare' diagram.

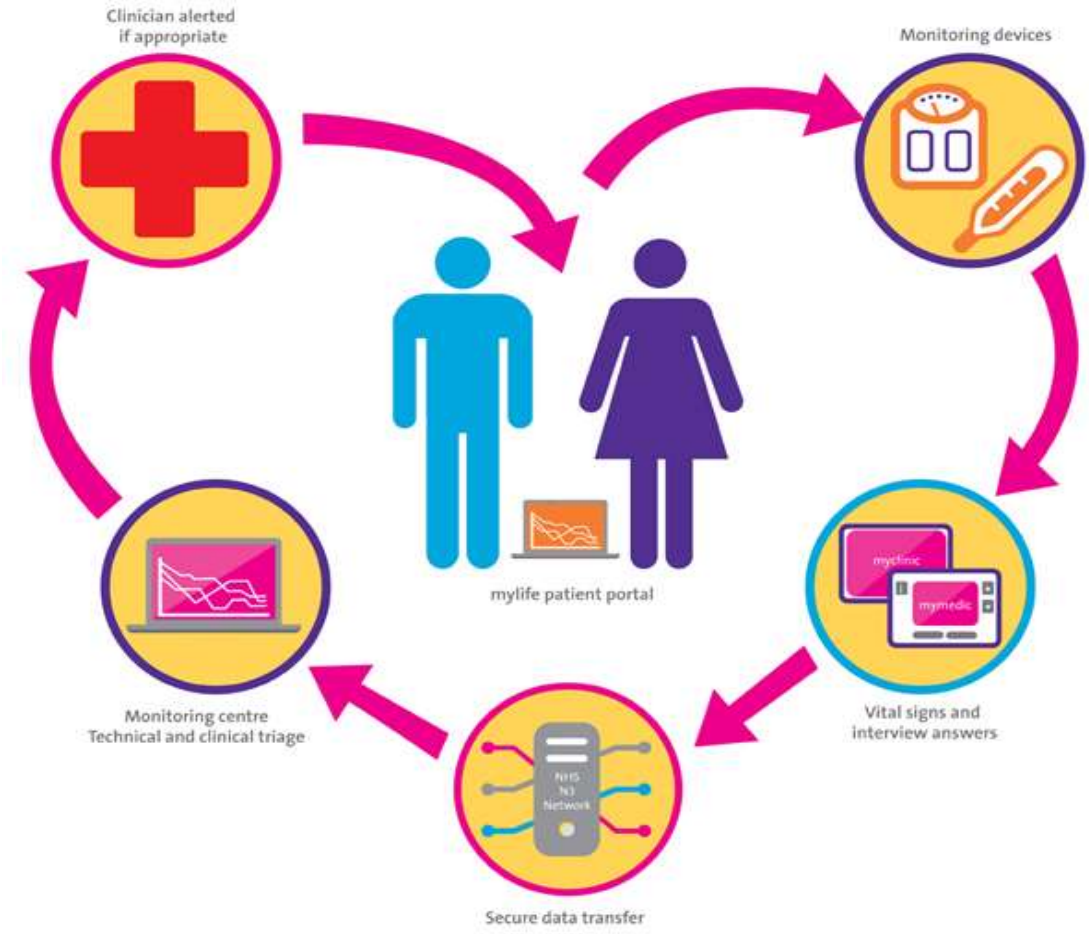

Figure 1. Remote U-healthcare Model (출처: [10])

The most basic service types of U-healthcare service are illustrated as follows:

1) The patient measures health information including blood pressure, blood sugar and oxygen saturation at home using a mobile device.
2) The patient sends bio signal measurements to a doctor or healthcare worker using an information communications network.
3) The doctor or healthcare worker provides feedback looking at the measurements.

The background of the advent of U-healthcare is presented below:

First, entry into the aging society accelerates. In the Korean society, the population of the elderly aged 65 or over reached 7.2% in 2000, and the entry into aging society has been predicted. If the current trend continues, the elderly will surpass 15% in 2020, and Korea will become a complete aging society (If a society

has more than 14% of elderly people aged 65 or over, it is called an aging society). Such a trend is the fastest among OECD member countries.

Secondly, medical expense is an increasing trend. Due to population aging and the increase of chronic disease patients, medical expenses work as a big burden on the part of the entire society. Among recent patients, the numbers of diabetics and high blood pressure patients are rapidly rising, due to living environment change. As such a trend is reflected, the medical expense per Korean person exceeds that of OECD average. U-healthcare, emerging in the IT (information technology) convergence and compound type, has come this way, while many concepts have been applied. Table 1 shows the transition process.

Table 1. Healthcare Transition History

	Communication Type	Property
1990 ~ 1995	Previous Network	Off-line treatment
1996 ~ 2000	High Speed Internet	Telemedicine service
2001 ~ 2005	Mobile Communication	M-healthcare (mobile phone usage)
2006 ~ Current	Ubiquitous	U-healthcare (Sensor, Home care)

Telemedicine is the use of telecommunication and information technology to provide clinical health care from a distance. It helps eliminate distance barriers and can improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations.

Although there were distant precursors to telemedicine, it is essentially a product of 20th century telecommunication and information technologies. These technologies permit communications between patient and medical staff with both convenience and fidelity, as well as the transmission of medical, imaging and health informatics data from one site to another.

Early forms of telemedicine achieved with telephone and radio have been supplemented with videotelephony, advanced diagnostic methods supported by distributed client/server applications, and additionally with telemedical devices to support in-home care [1]. The definition of telemedicine is somewhat controversial. Some definitions (such as the definition given by the World Health Organization [2]) include all aspects of healthcare including preventive care.

Telemedicine can be beneficial to patients in isolated communities and remote regions, who can receive care from doctors or specialists far away without the patient having to travel to visit them [4]. Recent developments in mobile collaboration technology can allow healthcare professionals in multiple locations to share information and discuss patient issues as if they were in the same place [5]. Remote patient monitoring through mobile technology can reduce the need for outpatient visits and enable remote prescription verification and drug administration oversight, potentially significantly reducing the overall cost of medical care [6]. Telemedicine can also facilitate medical education by allowing workers to observe experts in their fields and share best practices more easily [7]. Figure 2 shows Telemedicine Service in Philips Corp.

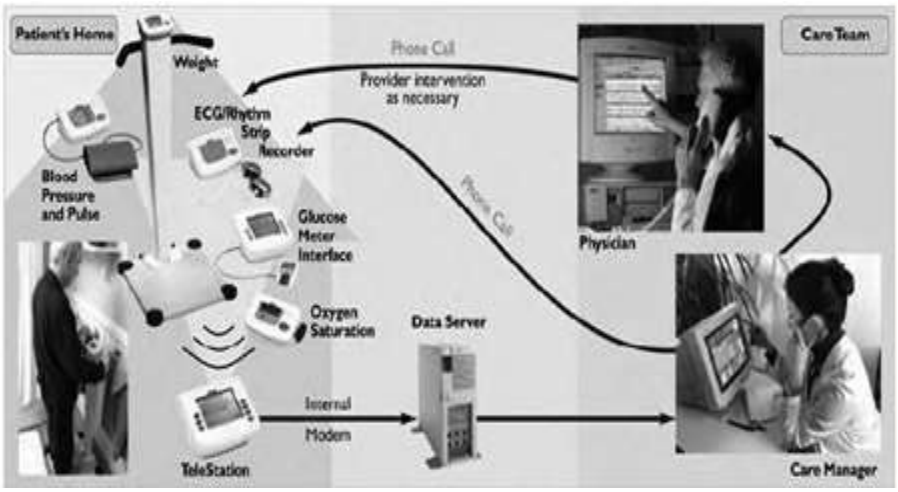

Figure 2. Telemedicine Service in Philips Corp

Figure 3 shows an example of telemedicine system used in telemedicine service.

Figure 3. Example of Telemedicine System

M-health is an abbreviation for mobile health, a term used for the practice of medicine and public health supported by mobile devices [1]. The term is most commonly used in reference to using mobile communication devices, such as mobile phones, tablet computers and PDAs, for health services and information, but also to affect emotional states [2]. The M-health field has emerged as a sub-segment of eHealth, the use of information and communication technology (ICT), such as computers, mobile phones, communications satellite, patient monitors, etc., for health services and information [3]. M-health applications include the use of mobile devices in collecting community and clinical health data, delivery of healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vital signs, and direct provision of care (via mobile telemedicine) [4].

While M-health certainly has application for industrialized nations, the field has emerged in recent years as largely an application for developing countries,

stemming from the rapid rise of mobile phone penetration in low-income nations. The field, then, largely emerges as a means of providing greater access to larger segments of a population in developing countries, as well as improving the capacity of health systems in such countries to provide quality healthcare [5]. Within the mHealth space, projects operate with a variety of objectives, including increased access to healthcare and health-related information (particularly for hard-to-reach populations); improved ability to diagnose and track diseases; timelier, more actionable public health information; and expanded access to ongoing medical education and training for health workers [3].

According to an analyst firm, around 2.8 million patients worldwide were using a home monitoring service based on equipment with integrated connectivity at the end of 2012. The figure does not include patients that use monitoring devices connected to a PC or mobile phone. It only includes systems that rely on monitors with integrated connectivity or systems that use monitoring hubs with integrated cellular or fixed-line modems. It forecast that the number of home monitoring systems with integrated communication capabilities will grow at a compound annual growth rate (CAGR) of 26.9 percent between 2011 and 2017 reaching 9.4 million connections globally by the end of the forecast period. The number of these devices that have integrated cellular connectivity increased from 0.73 million in 2011 to about 1.03 million in 2012, and is projected to grow at a CAGR of 46.3 percent to 7.10 million in 2017.[6]

The model of U-healthcare is medical institutions-centered model, namely, a service model to enhance treatment work efficiency of medical institutions or between medical institutions. User-centered U-healthcare model (home healthcare) is a service model to enhance treatment efficiency by connecting users outside medical institutions and medical personnel. The main role of user-centered U-healthcare is to conduct medical personnel's proper intervention, targeting chronic patients or people in health risk, and offer information to improve their sincere compliance.

The system components of u-healthcare need a convergence system, in which devices, solutions, communications network and IT services organically collaborate. Thus, relevant industries' growth is also expected. For example, the global home healthcare market was USD 1.5 billion in 2013, and this growth is projected. Currently, monitoring devices are the major product in the market.

The growth factors of U-healthcare service, in addition to the surrounding circumstances described above, are the increase of global elderly people population (elderly people aged 65 or over: 500 million in 2009 → 1 billion in 2030 is forecast), and the increase of chronic diseases and interest in disease prevention. Therefore, enormous growth is projected in the future. As more diverse and organic systems are developed, U-healthcare becomes segmented, and diversified. Korea's U-healthcare service industry is predicted to grow nearly four times in ten years. Figure 4 shows U-healthcare service components.

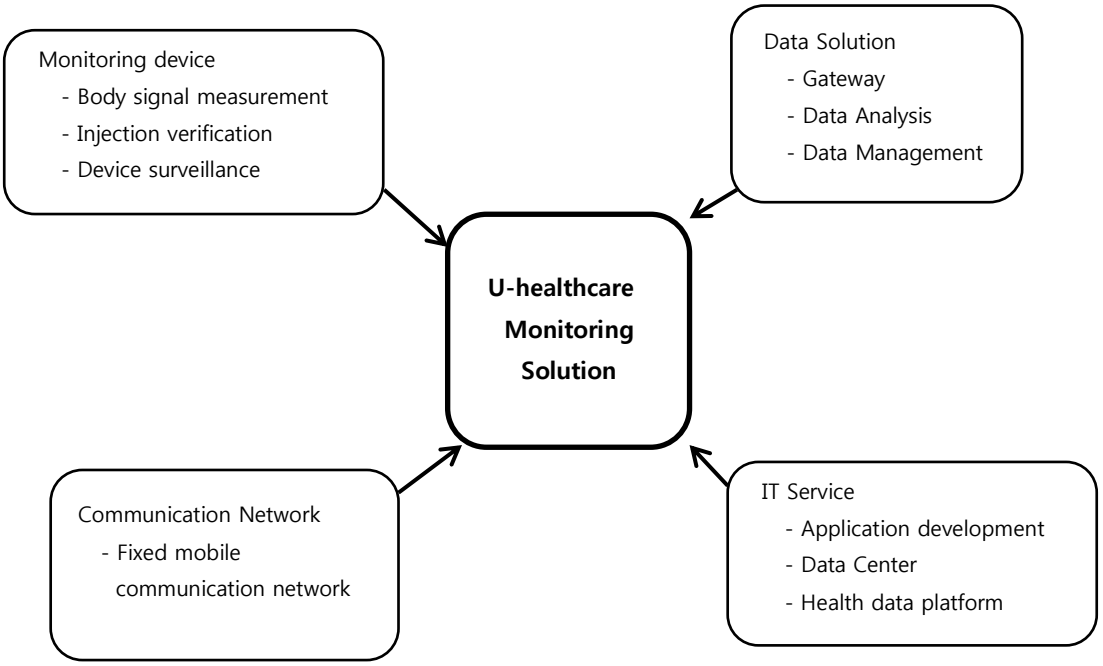

Figure 4. U-healthcare Service Components

2. Status of U-healthcare Usage

There are ten smart healthcare zones operated by an autonomous county in Seoul. The zone is the place where people can conveniently check blood pressure, and listen to the doctor's opinion. Starting with the lobby on the first floor of the County Building and Dietary Life Information Center of a Public Health Center in April 2011, the zone has penetrated four Dong-Community Service Centers having a high ratio of weak medical care brackets, a sports and cultural center, public health center branch and market merchant association buildings of markets having lots of floating population recently. Opening hours are from 9:00 am till the closing time of the venue concerned from Monday to Friday. The smart zone is very popular to the extent that the number of residents using the smart healthcare zone stood at 45,000 within one year of its operation. About 6,000 residents among them have registered as members, and receive healthcare service frequently [7].

The merits of the smart healthcare zone are high accessibility and convenience. Any residents who want to use the smart zone can meticulously check basic weight, body fat, the amount of muscles and basic basal metabolic rate (BMR) without membership. Men and women of all ages can easily use the equipment through voice guide and big sized letters on the kiosk screen. When automatic health measurement taking about five minutes is finished, the results are provided to the users through the kiosk screen immediately. Also, various graph type results can be displayed in linkage with the personal health record system.

More importantly, when a user wants to, the results can be assessed by medical personnel, and various solutions are recommended for healthier life. The county has organized a help desk by appointing professional personnel including doctor, nurse, exercise expert and nutritionists. The assessment result can be checked anytime, anywhere through an Internet homepage or to a mobile device. Also, the country supports by lending an RFID card and a 3D body activity gauge to the smart healthcare service members for a more convenient healthcare system. It is the

healthcare service suitable for the ubiquitous era. The age brackets using the service range from young people in their 20s to elderly people in 80s. Because the residents' responses are good, the county plans to add more than three smart healthcare zones.

The field in which U-healthcare service is most widely used and where its effect has been proven is the sugar blood level control of diabetics. In the event of the U-healthcare clinic of a hospital in Seoul, 50 diabetics sent self-blood sugar test values to the hospital using the Internet and cellphone. Generally, when an insulin-treated patient group controls blood sugar at a good level by taking a drug twice a day and a patient has diabetic drug once or more a day, or blood sugar is controlled with only dietary therapy, 2~3 times of blood sugar level measurement a week is recommended. This clinic recommends maintaining HbA1c (ratio of combination with blood sugar out of total hemoglobin of red blood cells), which is the indicator reflecting the average blood sugar level for the recent three months, under 6.5%. Effective blood sugar control can be conducted by receiving blood sugar change pattern problems and an improvement method from a doctor frequently. When the blood sugar level goes up, a text message is sent, and a patient receives a warning telephone call from the doctor.

3. Problems of U-healthcare

According to social environment change, demand for smart healthcare combining IT with medical technology increases. Therefore, new conceptual healthcare systems using ubiquitous or mobile technology are appearing. However, current health and disease information collection technology is mostly about vital signs including blood sugar, blood pressure, electro cardiogram and body temperature. In this regard, technology to conveniently measure a variety of health and disease information including bio sensor is needed. Because many measurements are made by non-experts like the users of gauges, who are general public or elderly people, technologies improving the convenience of measurement type such as non-restraint and blindness measurement comprehensively analyzing such information should also be developed simultaneously.

As the healthcare paradigm shifts from disease treatment-focused system to individual-focused customized medical care, smart healthcare emerges. However, Korean U-healthcare has such limitations as the limit in biosensors and artificial intelligence technology, and the lack of successful business models.

The value chain circulation of companies, medical institutions, universities and research centers are severed, and thus, an ecosystem approach strategy is necessary. In this regard, the development of technologies like bio sensor, artificial intelligence and control system, as well as vision sharing and close cooperation of health and medical personnel, insurance, healthcare service, communications companies, devices companies and IT businesses are required.

The smart healthcare industry is a convergence industry, however, severance among industrial players occurs, and the industrial ecosystem has not been shaped well.

The previous government's following representative medical care industry policy problems should be improved: 1) Lack of long-term talent nurturing policy, 2) Inefficiency due to the lack of communication between ministries and between government and companies, 3) Short-term performance-centered health and medical industry policies, 4) Insufficient compliance inspection because of the lack of strategic focus, 5) Lack of control tower, 6) and Insufficient performance of cutting-edge medical care compound complexes and industrial ecosystem.

The commercialization of IT and medical fields combination is delayed, due to conflicting interests of hospitals, insurance companies and communications carriers,

despite derivative positive effects including various profits creation and medical expenses cut. Such a delay actually needs to be improved.

4. Development Directions

People can receive simple medical service at home without going to the hospital in the future by using smart healthcare using ubiquitous computing. Through biosensors attached to the human body, vital signs such as pulse and electrocardiogram can be monitored in daily life. Through such a monitoring process, when an abnormal symptom occurs in health, it is immediately sensed, and a necessary message is sent. With this, missing proper treatment timing can be fundamentally prevented. The real time-monitored data is comprehensively analyzed, based on specialized medical information, and treatment for simple disease is possible, without having to visit the hospital. As necessary, the diagnosis of medical personnel can be received remotely by connecting with medical institution for the disease concerned. More importantly, medical services from a medical institution can be hugely improved for the residents located in remote places. Although, diagnosis and prescription are important, the home nursing service can also be received at home using smart technology. The sensor on a drug bottle can check whether a patient had the drug, and can provide customized exercise therapy required for the patient and prevention information on various diseases to enhance treatment effect. In addition, patient-oriented service can be offered without hospitalization, since a patient can receive information on diet at home, which is equally important like drugs.

Examination, diagnosis and treatment conducted at hospitals can also become smarter. Like when one takes drug, when one swallows a nano capsule, the nano sensor automatically carries out image photographing and blood/tissue examination throughout necessary parts of the human body and the needed examination data is sent to the diagnosis system outside of the human body. The patient's medical data is accumulated and managed continuously throughout his/her life. Based on the accumulated data, the patient's status is comprehensively analyzed in an integrated manner including the data of all medical records and family disease history from the past to the present. The data analyzed as such is re-composed through 3D hologram images, and therefore, a cooperative diagnosis and treatment environment is offered. If augmented reality technology applies to actual data, the treatment environment including operation will be enormously improved. For example, multi-dimensional information like a patient's internal organs' locations and status is displayed to a doctor, according to a situation in real time, and the doctor can precisely recognize necessary information. In this manner, a more efficient and effective treatment and surgical procedure can be carried out.

With the shift into an aging society in the future, the demand to establish U-health systems seems to increase, and an expected demand on relevant technology export appears to exist. As Korea's economic power rises, average life expectancy increases, and the living environment changes. Consequently, the numbers of elderly people and chronic disease patients such as those with diabetes or high blood pressure go up. In such a situation, interest in the U-healthcare industry, which is IT convergence and compound industry, is on the rise. This study identifies the current status and problems of U-healthcare service. For U-healthcare industry to be activated more than it is now, an effort to enhance the precision of relevant compound technologies should continue, and back up should be continuously improved from standardization, relevant legislature and institutional aspects.

5. Conclusions

Ubiquitous actually means the environment and space receiving services, while a user is on an online network using anything, anytime, anywhere. The big proposition is that a chip exists in everything. A chip-embedded thing then becomes a computer, and humans live with these computers. From an information and communications perspective, a “ubiquitous” system is creating a new paradigm in all social fields. The fields are not some specific fields, but all fields in existing society are encompassed. In this paper, we examine the concept of U-healthcare. In U-healthcare, people can receive simple medical service at home without going to the hospital in the future by using smart healthcare using ubiquitous computing. Through biosensors attached to the human body, vital signs such as pulse and electro cardiogram can be monitored in daily life. With this shift into an aging society in the future, the demand to establish U-health system seems to increase, and expected demand on relevant technology export appears to exist. Consequently, the numbers of elderly people and chronic disease patients such as those with diabetes or high blood pressure go up.

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