Chapter 5

Mobile Cloud-Based Blood Pressure Healthcare for Education

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Abstract

Mercury, pneumatic, and electronic sphygmomanometers were widely used for traditional blood pressure (BP) measurement. Cloud BP database, and mobile information and communication technology (MICT) do not integrate to these BP measurement methods. Pen and papers were employed to record BP values for nurses and physicians, and recording errors are possible to occur. In the chapter, the cloud-based BP platform solution and advanced wireless hospital BP measurement technologies were studied. These cloud-based BT measurement technologies were used as teaching aids to train students of electrical and nursing fields for mobile BP healthcare and health promotion education, and hence interdisciplinary teaching and learning were conducted. The teachers include professors of electrical and nursing fields, physicians, hospital nurses, and the engineer and health management experts of Microlife. The interdisciplinary teaching and learning of mobile BP healthcare and health promotion for smart aging were conducted in the Department of Nursing Division, Chang Cung Memorial Hospital, Keelung Branch, Department of Nursing Ching Kuo Institute of Management and Health, School of Nursing Chung Shan Medical University, and Department of Electrical Engineering, National Taiwan Ocean University. The students of electrical and nursing fields participated for joint interdisciplinary learning. The concepts of interdisciplinary mobile BP healthcare learning and teaching involve nursing and technology, healthy aging, BP health care for smart aging, telenursing, BP care for smart aging, community/home telecare, and MICT. The objective of teaching and learning is training the design and making electrical engineers to understand BP healthcare and health promotion, and nurses to understand mobile BP healthcare and health promotion system for smart aging.

Keywords: BP healthcare, smart aging , cloud-based BP measurement technologies, jointly interdisciplinary learning and teaching, mobile information and communication technology

1. Introduction

In this chapter, computers, Internet access, mobile computing, Web page systems, short messaging services, multimedia messaging services, and e-mails were examined with respect to students of medical, nursing, and health science disciplines [1]. The advanced technologies help health science students to access healthcare information and adopt effective methods to develop their skills. Mobile information and communication technology (MICT) has been used in the learning and teaching process of health and medicine science education, and has enabled learning and access to health education knowledge anywhere and at any time [2]. Mazzola et al. [3] demonstrated how physical activity, nutrition, and training through a combination of processes and mobile technologies are related to overweight teenagers and obesity in behavioral education. The People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast (PEGASO) scenarios [3] include motion sensors to detect physical activity, GPS location service, and the smartphone acts as a communication gateway for these sensors with feedback functions and information. The awareness and self-management of obesity risks are important to motivate teenagers to engage in affective learning and trigger a behavioral change. Smartphone applications were exploited to improve participants' health-related quality of life and healthcare utilization for rheumatic diseases self-management [4]. Disease-associated self-management strategies can be designed using mobile health (mHealth) technologies. Azevedo et al. [4] reviewed several aims, platforms, and characteristics of smartphone applications for self-management of rheumatic diseases.

mHealth is a "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" [5], and is recognized by the World Health Organization. Advanced mobile Web-based and Internet technologies have transformed current healthcare models with regard to monitoring of physical activity or encouraging physiological changes that stimulate positive health behaviors. Zhang et al. [6] illustrated how to extend a mobile Web-based app with multimedia features for psychiatry education in Singapore, and found out through a survey that MICT helped them save a significant amount of time in clinical activities. MICT must ensure that the physiological signals provided within are accurate and credible. Healthy behaviors (e.g., sports lifestyle, healthy eating habits, and blood pressure (BP) monitoring) help in reducing fatal health risk, disability, healthcare use and health-related costs [7]. Weight management, physical activity, smoking cessation, self-management of diabetes mellitus, and hypertension care using MICT were demonstrated [8]. MICT-supported health behavior interventions are designed to prevent or manage illness and lead to fundamental changes in health practices, thereby, providing an opportunity to stimulate and sustain healthy behaviors [6, 7]. Chan et al. [9] described that problem-based learning using multimedia, such as video clips, Web sites, images, or photos, was implemented in the health sciences learning process, and students could use their mobile Internet technology to access the knowledge and enhance their process of learning using laptops, tablets, and smartphone mobile devices on a cloud-based learning platform. Problem identification, problem description, problem exploration, applicability, and integration strategies were recommended in the problem-based learning approach [10].

Elliott et al. [11] implemented a mobile electronic health records (EHR) system for medical education. The functionality, connectivity, ease of use, and usage challenges of the developed EHR system in the hospital environment were investigated for learning. Davies et al. [12] developed a mobile learning model using a personal digital assistant (PDA) loaded with medical resources for undergraduate medical students in the clinical environment. MICT was used to provide new learning methods with respect to problem identification and solving skills. ISO/IEEE 11073 and Health Level 7(HL7) V2.6 protocols were used to develop and evaluate self-management mobile Personal Health Record mobile health application for Android 4.0.3 by the Continua Health Alliance for continuous self-management of chronic disease patients [13]. It has the potential to promote new treatment and medical opportunities as well as to reduce medical costs and time for an aging society. It monitors their vital signs using mobile network technology (MNT); thereby, ensuring better healthcare. The user interface, applications, seamless transmission protocol, personal health record, and database managers were demonstrated for the application.

Wu et al. [14] proposed a cellular and iridium network-based blood pressure and body temperature remote measurement platform for mobile healthcare education. The overview of mobile telemedicine research fields was provided by Lin [15, 16]. In previous studies [17–21], 802.11n and ultra-wideband wireless telemedicine transmission schemes, multicode code division multiple access (CDMA) cellular mobile telemedicine transmission mechanism, and multi-satellites wideband CDMA and orthogonal frequency division multiplexing (OFDM) transport architectures were proposed. In this article, a cloud-based mobile blood pressure (BP) healthcare education program for smart aging is investigated.

2. Teaching methodology and concept

Our teaching team included professors from electrical and nursing fields, as well as physicians, the engineers, and health management experts for Microlife. Cloud-based and mobile BP healthcare knowledge was the focus of studies for students in electrical and nursing fields. The could-based and mobile BP platform of Microlife was used in the healthcare program for interdisciplinary learning. The tele-BP healthcare for smart aging course was offered through the Department of Electrical Engineering, National Taiwan Ocean University, and the School of Nursing Chung Shan Medical University, during February 2014 and June 2014. Fourteen students in the electrical field and 19 nursing students participated for joint interdisciplinary learning. The distance between National Taiwan Ocean University and Chung Shan Medical

University is 180 km. Facebook videoconferences were used for team discussions associated with problem-based learning and problem solving. The BP healthcare for smart aging course was offered through the Department of Electrical Engineering, National Taiwan Ocean University, and the Department of Nursing, Ching Kuo Institute of Management and Health, during September 2014 and January 2015. Thirteen students in the electrical field and 34 nursing students participated for joint interdisciplinary learning. In the learning teams, students in the electrical field provided the MICT know-how, and nursing students contributed user experience and healthcare knowledge. The course outline of tele-BP healthcare for smart aging is as follows:

- Nursing and technology
- Healthy aging
- BP healthcare for smart aging
- Telenursing

Video materials were recorded and uploaded to the course Web site for students enrolled in the course so that they could download the information to study anytime and anywhere.

Nursing and technology video material [22]: Lu discussed the relationship between nursing and technology, technology's effects on nursing, the connection between nurse's experiences with technology and new technology design, advanced nursing processes, future trends in nursing education, and future trends in the development of nursing technologies.

Healthy aging video material [23]: Lu defined aging and discussed the aging process, changes in bodily functions, longevity, elderly food intake and arrangements, elderly movement, and approaches to caring for the elderly, as well as definitions of healthy aging, aging attitudes, and planning.

BP healthcare for smart aging video material [24]: Lin discussed health and medical, issues, medical care for smart aging, cardiovascular disease, BP definition, the principles of BP changes, classifications of hypertension, techniques and times for measuring BP, and principles and operational modes regarding mercury, pneumatic, and electronic sphygmomanometers. Other topics included risk factors, symptoms, and complications of hypertension, and preventive measures for the disease.

Telenursing video material [25]: Lu discussed the definitions of telehealth, telecare, telemedicine, and telenursing, community-based telecare, home-based telecare, and agency-based telecare, as well as the roles, opportunities, and challenges of telecare nurses.

The course outline of BP healthcare for smart aging is as follows:

- BP care for smart aging
- Community/home telecare
- MICT

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BP care for smart aging digital material [26]: Wang discussed the significance of low and high BP, the factors influencing BP, the significance of BP tracking, the risk of brain/cardiovascular disease associated with BP, and the challenge of telecare.

Community/home telecare digital material [27]: Wang discussed community-based telecare in Taiwan, the project model for telecare, physiological signal monitoring, locations and energy services for smart aging, health counseling and interpersonal assistance for smart aging, and design considerations for products for smart aging.

MICT digital material [28]: Lin discussed the definition and history of communication technology, definition and history of the Internet, introduction to multimedia communications and communications and network infrastructure in Taiwan, mobile communications and networks, the architecture of telecare, and the definition and history of telemedicine.

3. Experiment-based and visit-based learning

In the experiment-based learning process, interdisciplinary students can understand the principle and technology of mobile BP healthcare solutions for smart aging. **Figure 1** shows several BP measurements for the same personal, taken in different situations. The systolic BP values for lying, sitting, standing, and walking are 122, 123, 128, and 136 mmHg, respectively. The diastolic BP values are 62, 70, 75, and 90 mmHg, respectively. We observed the range of the systolic and diastolic BP values by taking measurements in several situations. The maximum measurement value of BP is reported for walking, and the minimum measurement value is reported for lying.

Figure 1. Several BP measurements for the same personal taken in different situations.

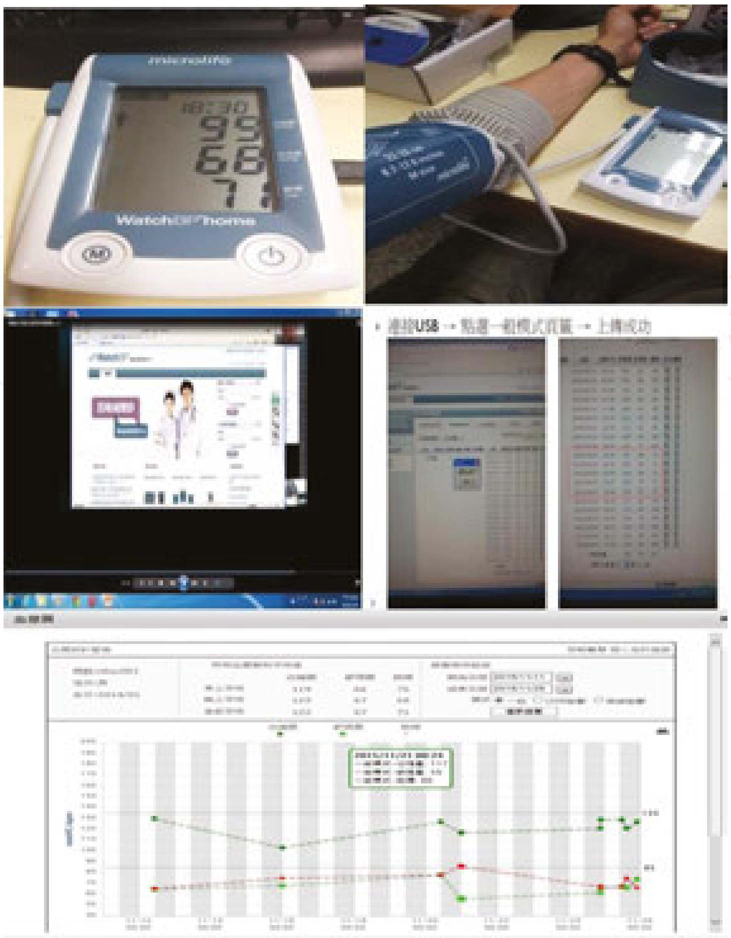

Figure 2. The cloud-based BP platform solution developed by Microlife [29]. Values are presented.

As shown in **Figure 2**, the cloud-based BP platform solution developed by Microlife was adopted in the course to train students in mobile BP healthcare [29]. The BP measurement times were before sleep and after getting up, and the times were recorded with a USB-based sphygmomanometer that can store 256 BP measurement times, as well as the values for pulse, diastolic, and systolic BP. These values can be uploaded to the cloud-based mobile BP platform from the USB-based sphygmomanometer using a USB transmission interface. In the cloud-based BP platform, the BP measurement time and pulse, diastolic, and systolic BP values are recorded, and the trend and changes of pulse, diastolic, and systolic BP are noted.

We can also obtain the sleep habits of the cloud-based BP platform users. The joint interdisciplinary learning process for cloud-based BP healthcare solutions in the courses of tele-BP healthcare and BP healthcare for smart aging is shown in **Figure 3**. The third-generation (3G) mobile cellular network was used to connect notebooks to the cloud-based BP platform at anytime and anywhere. Observation, interdisciplinary cooperation, reverse thinking and feedback, innovative design, and an applied science and technology learning methodology were utilized. Cloud-based BP healthcare solutions for smart aging were learned, using integration, innovation, design, and thinking skills. The interdisciplinary students posed and answered the following questions:

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Figure 3. The joint interdisciplinary learning process for cloud-based BP healthcare solutions in the courses of tele-BP healthcare and BP healthcare for smart aging.

What healthcare services are available?

What kinds of smart aging groups are available?

Why are these kinds of smart aging groups suitable?

How are these kinds of smart aging groups used?

What kinds of carers and operators are needed?

What kinds of sensors and control devices are used?

What are the kinds of MICT devices, HMI, and network needs?

What are the functions of the cloud database?

What are the costs to be paid?

Who are the payers?

What are the self-management strategies of lifestyle and the treatment concept in mobile BP healthcare education for smart aging using MICT?

What are the advantages and disadvantages?

Figure 4. The interdisciplinary course outline of tele-BP healthcare for smart aging included a visit to the Department of Industrial Design, Shih Chien University, in July 2, 2014.

Figure 5. The interdisciplinary course outline of tele-BP healthcare for smart aging also included a visit to the Nightingale Nursing home for Smart Aging, Taichung, in June 2014.

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The interdisciplinary course outline of tele-BP healthcare for smart aging included a visit to the Department of Industrial Design, Shih Chien University, in July 2, 2014, as shown in **Figure 4**. Prof. Z.C. Wang presented the principle and technology of industrial design of nursing and a 3D printer. The course outline also included a visit to the Nightingale Nursing home for Smart Aging, Taichung, in June 2014, as shown in **Figure 5**. Students studied the life behaviors, diet, entertainment, and movement habits in the care center. In addition, the interdisciplinary course outline of BP healthcare for smart aging included a visit to a hospice and iodine 131 wards at Chang Cung Memorial Hospital, Keelung Branch, in November 2014, as shown in **Figure 6**, for an overview of the hospice practices. A video phone was used in an iodine 131 ward to provide real-time interaction between patients inside the ward and doctors, nurses, family members, and friends outside the ward. The video phone technology ameliorated the sense of helpless and anxiety felt by patients in the isolation iodine 131 ward. In addition, the cloud-based, wireless sphygmomanometers used in the Chang Cung Memorial Hospital, Keelung Branch, were observed. The medical record number, BP measurement time, and pulse, diastolic, and systolic BP values transmitted in real time to the cloud-based hospital care platform using the wireless transmission technology. Thus, the interdisciplinary students studied mobile BP healthcare for smart aging through visit-based learning.

Figure 6. The interdisciplinary course outline of BP healthcare for smart aging included a visit to a hospice and iodine 131 wards at Chang Cung Memorial Hospital, Keelung Branch, in November 2014.

According to the teaching and learning experience, as well as the visit-based experience described in the above explanation, the learning tool was developed for mobile hypertension education, as shown in **Figure 7**. The development learning tools included the proximal display software, a notebook, tablet, or personal computer with the Microsoft operating system, and a 3G mobile modem. The C# program was used to develop the proximal display software. The adaptive screen with large font solutions for smart aging, cloud-based BP measurement solution of Microlife, cloud-based BP measurement solution of Sunshine Instrument [30], SKYPE videoconference solution [31], and Messenger Plus videoconference recording solution [32] were all integrated with each other. Cloud-based sphygmomanometer and electrocardiography instruments are approved by Food and Drug Administration (FDA), and Taiwan FDA medical equipment, respectively. The videoconference and videoconference recording solutions can be used for team discussions relating to problem-based learning and problem solving. The mobile hypertension care process was studied as regards nursing students, and the proximal display software technology and the principle of MICT were studied as regards electrical students.

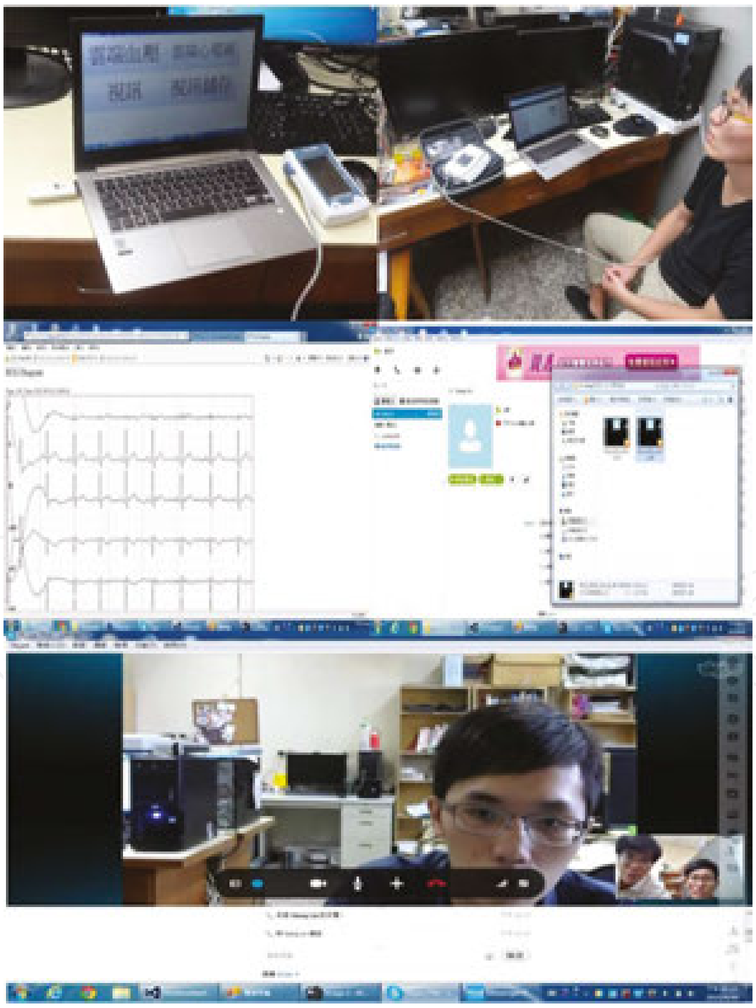

Figure 7. The learning tool was developed for mobile hypertension education.

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A learning tool developed by Microlife Corporation for 3G mobile agent and cloud-based multiuser real-time BP measurement system is shown in **Figure 8**. The 3G mobile agent and cloud-based multiuser real-time BP measurement system includes radiofrequency identification (RFID) cards, a Bluetooth-based sphygmomanometer, 3G gateway with Bluetooth network, 3G mobile modem, auto login sensor, and tablet. Each user has an RFID card, such as an Easycard, or a student card, to identify the user number. The Bluetooth-based sphygmomanometer is in a shutdown state. When the RFID-based student card senses the Bluetooth-based sphygmomanometer, the device is turned on, and the BP is measured. Real-time BP values are transmitted to the 3G gateway via the Bluetooth network, and a 3G mobile modem is used for transmission of these values to a cloud-based BP platform. When the RFID-based student card senses auto login, the auto login sensor uses the 3G mobile modem to login into the cloud-based BP monitoring Web page, and the real-time BP values in the Web page are displayed on the tablet. Each user can access BP reports on the cloud-based Web page at any instance from any global location.

Figure 8. A learning tool developed by Microlife Corporation for 3G mobile agent and cloud-based multiuser real time BP measurement system.

4. Conclusion

For students in electrical and nursing fields, mobile BP smart aging healthcare is a challenging area of joint interdisciplinary learning. A new educational model and innovative teaching methodology using a cloud-based mobile BP healthcare solution for BP healthcare smart aging education were proposed. Problem-based learning and a solving process, experiment-based learning, and visit-based learning were adopted. Facebook videoconferencing was used for team discussions of the problem-based learning and solving process among students in electrical and nursing fields. The cloud-based BP platform solution developed by Microlife was adopted in the course to train the students in mobile BP healthcare. This is a good learning and teaching program for mobile BP healthcare solutions for smart aging, and it is a beneficial contribution to the mobile BP healthcare industry of smart aging.

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