The Development of a Mobile Emergency Healthcare Information System in Taiwan

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Abstract: - Nowadays the quality of healthcare has been improved gradually. However, the time consuming pre-hospital emergency process could sometimes cause many regrets. Therefore, the minimization of time required for providing primary care and consultation to patients is one of the crucial factors when trying to improve the healthcare delivery in emergency situations. If the Emergency Medical Technician (EMT) can hold on signs of life of patients immediately when accidents happened, higher quality of healthcare could be achieved. Mobile healthcare is a new paradigm that combines the evolution of emerging wireless communications and network technologies to connect healthcare anytime and anywhere.
The purpose of the study is to develop a Mobile Emergency Healthcare Information System (MEHIS). A Standard Operation Procedure of Emergency Healthcare (SOPEH) is first planned. Then, the system is developed for EMT or families of patients to communicate with physicians in hospitals. Users can use their 3G mobile phone to transfer symptoms and information of the situation to JSP server which then quickly delivers information while providing proper emergency care at the prime time. Meanwhile, MEHIS can shorten emergency healthcare time and therefore enhance quality of emergency healthcare.

Key-Words: - Emergency healthcare, Mobile Emergency Healthcare Information System, 3G, EMT

1 Introduction

The quality of pre-hospital healthcare in the emergency healthcare system of Taiwan is needed to be improved. Resources of emergency healthcare are not allocated properly that pre-hospitals healthcare needs to be re-arranged. Meanwhile, index of pre-hospital healthcare quality is not unified, and Standard Operation Procedure of Emergency Healthcare (SOPEH) is not well developed to optimize efficiency and the quality [3].

Time is one of the crucial factors for improving the healthcare delivery in emergency situations. In general, an ambulance has to respond to an emergency call, administer first aid and then send the patient to an emergency ward in a close by hospital. The golden time for emergency rescue will be wasted under the situation of non-medical treatment. Therefore, any research about development of SOPEH and system will be a great help to improve crucial time of SOPEH. An Emergency Healthcare Information System helps patients or EMT to interact with physicians or a consultant in hospitals, first aids can be given immediately and hospitals can arrange necessary medical resource in advance.

The current Standard Operation Procedure of Emergency Healthcare in Taiwan is revised in the current research. Then, a Mobile Emergency Healthcare Information System (MEHIS) is developed based on the Third Generation (3G) communication technology.

2 Related Work

2.1 Emergency Healthcare in Taiwan

The department of emergency treatment of a hospital provides emergency medical service. Emergency Medical Service (EMS) is to give suitable treatment when accidents happen. The medical healthcare system of Taiwan has been established since 1968 [5]. Although the emergency treatment system of Taiwan has improved during the last 30 years, some researchers consider that it is not perfect. However, emergency treatment is an important category in medical service. Efficiency of the system and quality of emergency treatment procedure are urgent topics for improving cure rate. The current emergency ambulance delivery and treatment process of Taiwan is shown in Figure 1(Department of Health, Taiwan, 2006) [2]. Most of the time, patients are not adequately treated in the ambulance and they still need to wait for the

arrangement of medical resource or emergency treatment when an ambulance arrives in the hospital.

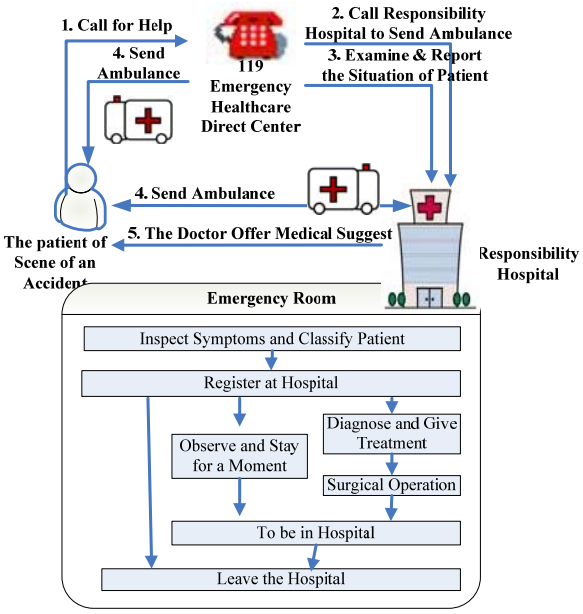

Fig. 1. SOPEH in Taiwan.

Slack and Slack (1972) believe that in an integrated basic medical treatment system, the function of the department of emergency treatment must include specialized service to examine and handle accident [1]. The operation of medical instruments is getting more and more complex and diversification. Therefore, hospitals should pay more attention to manage these instruments for providing high quality and safety environment [7].

Nowadays, many hospitals in Taiwan are planning to develop medical information system including information technology administration, electronic patient record, online registration and remote treatment. However, there are still many existing problems on emergency medical treatment, such as the disproportionate distribution and ambiguous medical information. Therefore, patients usually find that the resource is inadequate when they reach hospital so that they waste a lot of time transferring to other hospitals. Meanwhile, physicians can not prepare specific medical resource until patients arrive at the hospital. Actually, an ambulance can be changed into a moving emergency room by the wireless communication technology to improve these situations. Slack and Slack (1972) proposed that there are 3 characteristics of utilizing wireless communication for emergency treatment, including mobile ability, simplification and active [1].

2.2 Mobile communication and emergency mobile healthcare system

Digitalized communication and Time Division Multiple Access (TDMA) technique are adopted in second-generation (2G) mobile phone system. Usability of radio wave was dramatically improved and the number of mobile phones was propagated in late 1990s. Personal Digital Cellular (PDC) and Global System for Mobile Communications (GSM) are two major types of 2G communication systems; PDC is mostly used in Japan and GSM is widely used in European countries. However, the second generation mobile phone system is limited to a speed of 9.6 Kbps. Having just this bandwidth available, only low resolution static images and text-like patient data could be sent over the air.

In 1998, Code Division Multiple Access (CDMA) technique was used to provide mobile phone service, which was called 2.5G mobile phone service. Many European mobile phone carriers started General Packet Radio Service (GPRS) for providing high-speed transmission at about 115 kbps in the network of GSM system. This service permits data transmission rather than communication [8].

Third-generation (3G) mobile phone system is a digital mobile phone which utilizes the Universal Mobile Telecommunication Services (UMTS) technology. Because of the high operating flexibility and ability to provide a wide range of applications, it is a significant innovation over 2G and 2.5G systems. Nowadays, it generally extends the services to mobile customers. UMTS provides bit rates up to 2 Mbps. Since the CDMA system is adopted in 3G phone system, noise and cutoff in communication are reduced. Meanwhile, high-speed data transmission can be done at the maximum rate of 384 kbps at the most which was not achieved in 2G mobile phones [9]. Because the number of 3G cells is lower than those of 2.5G, a communication will have to fallback into GPRS speed, until it regains a 3G signal. Therefore, considerable delays exist in communication and data transfer.

With the emergence of cellular networks, a number of systems use cellular phones to transfer electrocardiogram (ECG) and heart rate [13]. Istepanian et al (2001a) utilized 2G Communications networks to address the ECG transmission issues [10]. Recently, several researches have been conducted to develop GSM based mobile health and wireless tele-medical systems for remote diagnosis in mobile and hardly accessible environments [11]. The European Union's Ambulance and its successive projects were able to transmit patients' biosignals or image sequences using available GSM phone lines [14]. The results show that their image transmission rate is one image (size of 2.5–3 kB) every 3–5s and the percentage of ECG transmission interruption reaches 27%. An Ambulance can be changed into a

moving emergency room by the wireless communication technology [6]. Istepanian et al (2006) presented a comprehensive review of wireless telemedicine applications and the latest advances on mobile health systems [12]. However, 2G mobile phone systems lack the necessary resources to transmit bandwidth-demanding real-time (RT) medical data. On the contrary, 3G mobile phone system overcomes the limitations.

3 Service analysis and system design

3.1 Research Processes

The process of the research is shown in Figure 2. Literatures about emergency healthcare system, mobile communication technologies and emergency healthcare in Taiwan were first explored in the research. Then the process of improved mobile version of SOPEH and the service model of emergency healthcare system were developed. Finally, the system was developed and evaluated.

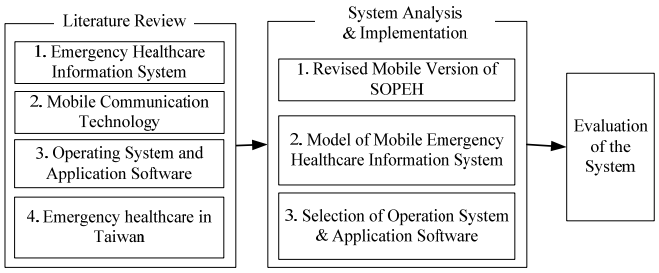

Fig. 2. Research Processes

3.2 Improved mobile version of SOPEH

The current emergency ambulance delivery and treatment process of Taiwan is modified and improved version of SOPEH is shown in figure 3.

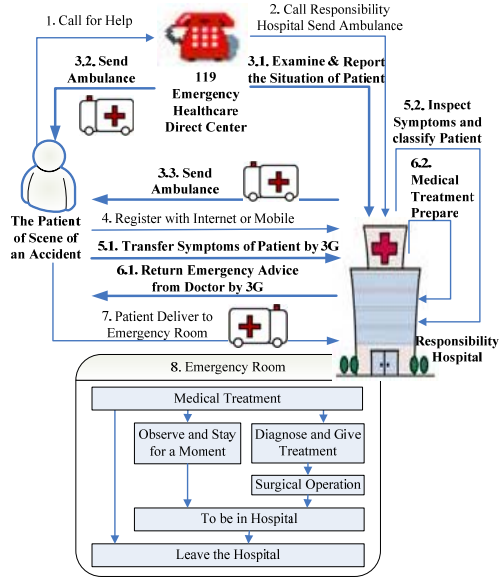

Fig. 3. Improved mobile version of SOPEH in Taiwan.

In Figure 3, step3.1 and step 3.2 and 3.3 are carried on at the same time when patient is delivering to the hospital by ambulance. Meanwhile, step 5.1 and step 5.2 are executed at the same time. Eventually, physicians can transfer emergency advice to the ambulance and prepare treatment needs in the hospital in advance. For emergency patients, it is an important issue to avoid wasting golden time on sudden outbreak and medical mistakes. Therefore, valuable treatment time of patients could be saved and cure rate will be improved by the mobile version of SOPEH.

3.3 System Architecture of Mobile Emergency Healthcare Information System

The Mobile Emergency Healthcare Information System (MEHIS) includes two parts, user side terminal and hospital side terminal as shown in Figure 4. Mobile devices are used to transfer patients' symptom information to the responsibility hospital, receive advices from physicians, register, and download emergency care procedure through Mobile Emergency Healthcare System during the delivering process to the hospital. Meanwhile, patients can use desktop computer to register through Internet. 3G communication technology is utilized to transfer information. On the other side, physicians or nurses in the hospital can access patients' electronic record via mobile devices or PC to arrange healthcare equipments or advise emergency care for patients in the ambulance. The hospital side of the system includes the rule based server, the mobile service server, and the electronic patient record database server which provide information for users, physicians, and nurses.

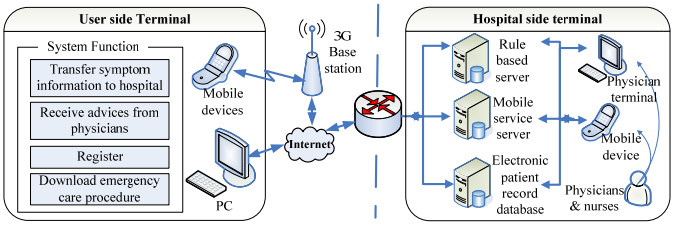

Fig. 4. Architecture of Mobile Emergency Healthcare Information System(MEHIS)

3.4 System Functions

The functions of MEHIS developed in the research are shown in Figure 5. Registration, transfer of symptoms, advice, and maintenance are major functions of the system. The server and component layers are developed to support functions for providing convenient and comfortable usage of emergency healthcare services. Patients or their

family can register via mobile devices and communicate with hospital at needed. Then, physicians' advice is sent to patients' site as soon as the situation is analyzed. Application server is responsible for providing patients' medical records and related instruments and medicine. Rule based server is designed to store rules of medical treatment and transforming components for applications which are designed to make decision and decrease the computing load from application server.

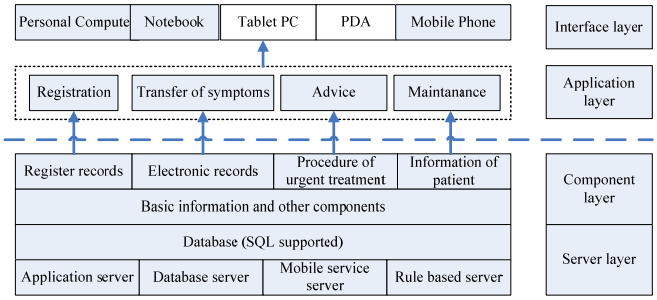

Fig. 5. Functions of Mobile Emergency Healthcare System.

4 Implementation and Evaluation

4.1 Implementation

The system was developed by Java language, including Java2 mobile edition, Java Server page. At the same time, MySQL server was adapted as database server and the other J2EE server was setup based on it. It is in charge of controlling the rule base and receiving the information from client whether it is a PC or a mobile device. The system supports all platforms. The system consists of two main user terminals, the hospital side and user side. Users report symptoms via the user side terminal. The hospital side terminal provides an interface for physicians to review patients' electronic medical record, and can key in advices for urgent treatment. Then, advices are sent to mobile devices in the accident site. Meanwhile, the information is stored in the database for future proof reference. An example of hospital side interface is shown in Figure 6.

The interface of user site of using 3G mobile phones is shown in Figure 7. The system includes four main functions, login, transfer symptom, register, and download emergency treatment advice. Figure 7(a) shows that users can select the menu to login the system. Figure 7(b), (c), (d), (e), (f), and (g) shows the process of how users report the symptoms of patients. Figure 7(h), (i), (j), (k), and (l) shows the process of how users download emergency treatment advice.

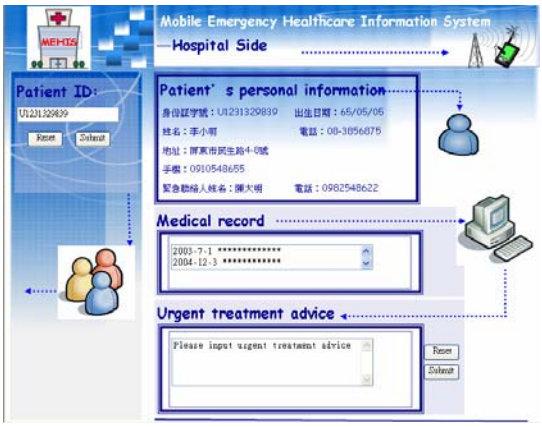

Fig. 6. An example of interface of hospital site.

Fig. 7. An example of interface of user side terminal.

4.2 Evaluation

An anonymous survey was conducted to understand users' opinions about the effectiveness and usefulness of the system. The survey consists of 40 questions and 30 volunteers participated after using the system. The questionnaire includes four categories: interface design of the system, features promoting usage, perceived effectiveness and usage enjoyment. Data was collected over a period of four weeks during June, 2006. The mean and standard deviation for each category and some of their items, where its score is higher than 3.0, are shown in Table 1. Perceived effectiveness has the highest mean score which means that users felt the mobile emergency healthcare system was effective for emergency healthcare through using it. The perceived effectiveness has the highest mean score. The result reveals that users felt the system is useful when an accident happens.

Table 1. Descriptive analysis of questionnaire data

Category	Mean	Standard deviation
Interface design of the system	**3.27**	**0.43**
2. Guideline of interface operation	3.41	0.78
7. Usage friendliness	3.32	0.69
Features promoting usage	**3.48**	**0.61**
12. Useful system function	3.65	0.71
13. Clear function purpose	3.43	0.80
17. Well structured operating procedure	3.39	0.81
Perceived effectiveness	**3.51**	**0.55**
21. Enhancing the opportunities of survive	3.72	0.85
25. Enhancing the ability of emergency treatment	3.56	0.91
Usage enjoyment	**3.39**	**0.51**
34. Enjoying usage of the system	3.32	0.83
36. Easy of operation	3.58	0.75

5 Conclusions

The revised mobile version of SOPEH can improve the procedure of emergency care and the development of the MEHIS can be used in ambulance to transfer symptoms information. Meanwhile, the responsibility hospital can continue classified trauma of patients, and ambulance can receive physicians' emergency advice beforehand. Therefore, the emergency healthcare can reduce many paraphernalia. The most important thing is that it enhances rescue rate of patients by using mobile SOPEH and MEHIS.

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