Smart Emergency Medical Services Integrated with EMR-connected Wearable Devices

Yeongcheol Shin, Gibaek Nam, Eunjeong Park, Taehwa Han, and Hyuk-jae Chang

Abstract— We developed a prototype in demonstrating the interoperability of IoT healthcare platform for daily healthcare integrated with emergency medical services. For the processes of developing a prototype, we implement a smart emergency medical system (SEMS) which utilizes the wearable devices called Lifetag providing extracted information from electronic medical records (EMR). Lifetag facilitates the information management of paramedics by referring the current health status of people who are in need through the NFC communication between paramedics' smartphones and Lifetags. In addition, SEMS integrates physiological signals from patient monitoring devices in an ambulance to a pre-hospital care chart which transfers collected information to the national emergency department information system (NEDIS).

Research Keywords— healthcare system; interoperability; mobile healthcare; service integration; emergency medical service

1 INTRODUCTION

In the situation of a disaster, the timely and accurate information sharing could reduce the number of causalities through the efficient collaboration between various actors such as paramedics, local hospitals and disaster management department [1]. Particularly, the prompt acquisition of a patient's medical information including the specific allergies and chronic diseases allows the medical staffs to conduct the proper management of a patient on time [2]. Hence, there have been some efforts to have the interoperability between diverse medical information systems and devices. Nonetheless, the main cause of incorrect data which might have been responsible for certain number of deaths each year occurs to be the fragmented health information within the integrated systems.[3]. In this study, we have implemented the prototype of smart emergency medical system (SEMS) in connecting the patient's medical history and physiological signals for the pre-hospital care management system. Additionally, we have built the disaster management system which utilizes the e-triage via beacon to track and collect the relevant information from the emergency scene. The system that we propose collaborates the wearable medical identification through NFC communication in connection with hospital information system (HIS) along with the standardized data integration of monitoring devices and pre-hospital care chart. Fig.1. shows Elements of SEMS system.

The rest of this paper is organized as follows. In Section II, we address the existing challenges regarding the smart emergency medical systems and attempt

- *Yeongcheol Shin is master's degree student in Biomedical Engineering and with Health-IT-Acceleration center from Yonsei University College of Medicine, Seoul, Korea. (e-mail: Ycshin4712@yuhs.ac).*
- *Gibaek Nam and Taehwa Han are with Health-IT Acceleration Center, Yonsei University College of Medicine, Seoul, Republic of Korea (e-mail: gbnam@yuhs.ac, taehwa.han@gmail.com).*
- *Eunjeong Park is with Health-IT Acceleration Center, and Cardiovascular Research Institute, Yonsei University College of Medicine, Seoul, Republic of Korea (e-mail: EUNJUNG-PARK@yuhs.ac).*
- *Hyuk-jae Chang is with Health-IT Acceleration Center, and Department of Cardiology, Yonsei University College of Medicine, Seoul, Republic of Korea (e-mail: HJCHANG@yuhs.ac).*

Fig. 1. Elements of SEMS system.

to suggest some plausible solutions based on the utilization of wearable devices. And also we introduce the adaptive emergency medical systems by describing the software architecture. In section III, we discuss about survey for SEMS platform, and then Section IV will be our conclusion.

2 CONCEPT AND MODEL

2.1 Concept

SEMS is a collaborative platform consisting of (A) Lifetag system within mobile devices which extracts the patient's medical history from HIS; (B) E-triage which collects the casualty information including the intelligent decision of a triage; (C) a EMS management system via beacon from the ambulances and crew's ID cards; (D) smart pre-hospital care chart integrating the physiological signal from patient monitoring devices such as defibrillators, and (E) information transfer system connected to emergency rescue servers. Based on the elements above, we have implemented SEMS incorporating with the portable medical identification – Lifetag – allowing the involved actors (from patients to their family members, and paramedics) to have an access to the individual health history.

The SEMS system architecture is shown in Fig 2. The components including Lifetag wearables, Lifetag mobile systems, patient monitoring devices, and smart emergency care chart are interfaced with the standardized medical information.

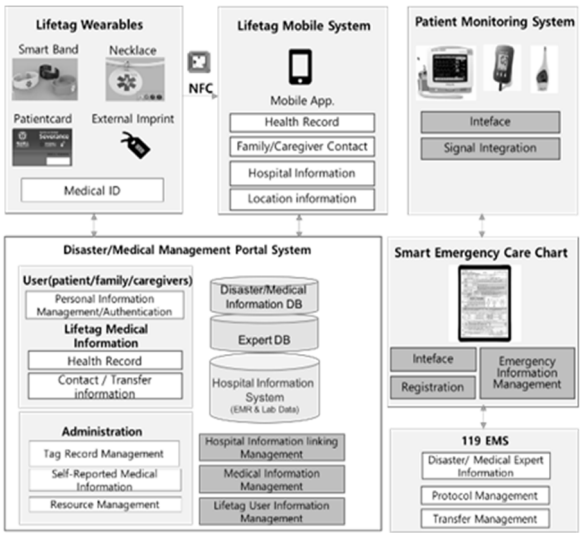

Fig. 2. SEMS System architecture

Fig. 3. Lifetag connection to hospital information systems through NFC communication

2.2 Model

2.2.1 Lifetag: a Wearalbe Medical Identification Integrated with EMR information

SEMS utilizes the interface module for Lifetag system and HIS. The EMR agent server extracts current health information from EMR and Lifetag database is updated daily for the purpose of providing the up-to-date health information. The primary source is the electronic medical information covering allergy, blood type, diagnosis, doctor operation, dialysis, medication, and lab test result.

Various types of LIFETAG such as wristbands, necklaces, patient ID cards, stickers, and USB devices have been designed and used. Fig.3. shows a way how to use lifetag.

2.2.2 Real-Time Integration of Biosignals

We constructed an automated transmission of physiological signals to pre-hospital care report and SEMS servers. Biometric information measured in medical equipment operated in the ambulance are gathered for automatic editing of smart care chart. The smart care chart reduces the burden of redundant work of information collection and intelligently alarms the risky signals to prepare proper treatment in hospitals.

2.2.3 E-Triage for Disaster Management

SEMS aims an enhancement of effectiveness of a field rescue activity through automatic retrieval and integration of physiological signal and e-Triage. We designed beacon applications for e-Triage and location information processing along with the augmented reality based on disaster information management.

2.2.4 Smart Emergency Care Chart

We have constructed integrated information database including patient information, rescue activity information, and disaster scene information. As shown in Fig. 4. (b), SEMS adapts the flow of data and operations for Lifetag users and general users.

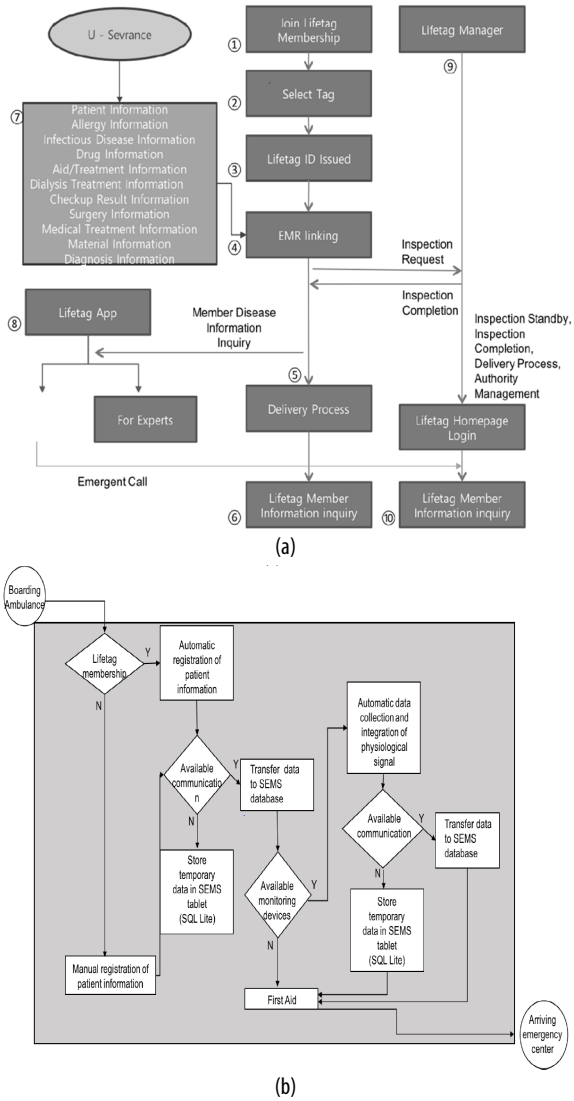

Fig. 4. Example flow of SEMS service scenario. (a) lifetag service of EMRconnected wearables, and (b)service flow of an emergency medical service.

3 Experipments

As a pre-study of the SEMS implementation, we collected the qualitative factors in EMS system by surveying paramedics perception for SEMS platform. Total of 113 paramedics working at fire stations in Seoul and Incheon participated in the survey.

The main results from the survey are as follows:

First, both paramedics and medical staffs in emergency center need to share the information of emergency scene and patients during delivery. A total of 43% participants have shown positive view for data sharing, and 24% of participants has shown strong necessity.

Second, the acquisition of information including patients' health history and contact number will facilitate first aid activity. A total of 61% participants have indicated the necessity of automatic acquisition of patient information, and 18% of participants stressed the imperative needs.

4 Conclusions

We introduced SEMS integrating EMS management system, wearable devices for medical identification, and real-time patient monitoring in ambulances. SEMS enables timely and accurate information sharing in the situation of disaster. The utilization of beacons facilitates the efficient data management by automatic registration of rescue activities and the collection of casualties.

Acknowledgment

This research was supported by the Field-oriented Support of Fire Fighting Technology Research and Development Program funded by the National Fire Agency, Republic of Korea (MPSS-2015-70) and by a grant funded by the Ministry of Trade, Industry and Energy (10060085) and supported by Next-generation medical technology Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and Future Planning (2016M3A9F1941829).

References

[1] Y. Yusoff, A. A. Bakar, N. Aziz, R. Ismail, and R. Ramli, "Ascertaining Trust of Information Transmitted During a Disaster," Journal of Telecommunication, Electronic and Computer Engineering (JTEC), vol. 8, pp. 119-124, 2016.

[2] M. Ebinger, B. Winter, M. Wendt, J. E. Weber, C. Waldschmidt, M. Rozanski, et al., "Effect of the use of ambulance-based thrombolysis on time to thrombolysis in acute ischemic stroke: a randomized clinical trial," Jama, vol. 311, pp. 1622-1631, 2014.

[3] M. Abdelhak, S. Grostick, and M. A. Hanken, Health information: management of a strategic resource: Elsevier Health Sciences, 2014

YeongCheol Shin received the B.S. in Information Communication engineering from Hansung University, Seoul, Korea in 2016. He is master's degree student in Biomedical Engineering and with Health-IT-Acceleration center from Yonsei University College of Medicine, Seoul, Korea. His main research interest is in service design for clinical decision support system such as early stroke detection system using machine learning algorithm.

Gibaek Nam received the B.S. in Information and Communication Engineering from Gangneung-Wonju National University in 2016. He is currently a Researcher of Health-IT Acceleration Platform Technology Innovation Center(HAPTIC), Seoul, Korea. His current research interests include machine learning, computer vision.

Eunjeong Park (M'07) received the Ph.D. degree in computer science and engineering from the Seoul National University, Seoul, Korea, in 2006. She is currently a Research Assistant Professor of Cardiovascular Research Institute at the Yonsei University College of Medicine, Seoul, Korea. She served as a Research Manager for the UCLA Wireless Health Institute, University of California, Los Anges, CA, USA and a Research Professor for the Embedded System Research Center, Ewha Womans University, Seoul, Korea. Her current research interests include healthcare systems, intelligent medical informatics, and mobile computing.

Taewha Han received the Ph.D. degree in computer science from Gyeonggi University, Suwon-si, Gyeonggi-do, Korea, in 2005 and Ph.D. Candidate in Medical Science/Radiology from Ajou University, Suwon-si, Gyeonggi-do, Korea in 2011. She is currently a Research professor of affiliated with medical engineering department, R&D on health IT platform and services. And also she is expert reviewer of contribution in forming the relevant direction within academic research policy committee, Health management program advisory commission of advice on the management of health promotion-related programs, Expert Committee Member (Non-executive) of Advice and review on u-Health and wellness service model based on BigData and Standardization at the national health insurance service (NHIS). Also, she is a co-convenor of IEC SYCAAL WG5 and expert of IEC TC 62. Her current research interests include Standardization of medical information, medical imaging informatics and health-ICT.

Hyuk-Jae Chang received his MD from Yonsei University Medical School, Seoul, Korea, in 1994. He received master's degree in Yonsei University Medical School, Seoul, Korea, in 1999. He recieved PhD from Ajou University Medical School, Gyeonggi-do, Korea, in 2003. He is currently a Professor in Yonsei University, College of Medicine and a director of Yonsei-Cedars-Sinai Integrative Cardiovascular Imaging Research Center, Seoul, Korea. He is interested in imaging and multi modality medical ICT