

THE DEVELOPMENT OF A PROTOTYPE E-P.O. BOX AND ITS APPLICATION TO PERSONAL HEALTH INFORMATION MANAGEMENT SYSTEM

Joong-Sun Lee¹, Hiroyuki Suzuki¹, Naoko Taira¹, Kouichi Kita², Takashi Obi¹
Masuyoshi Yachida¹, Takahiro Yokoyama¹, Hiroshige Yamamoto¹, Kazuhisa Uryu¹
Masahiro Yamaguchi¹ and Nagaaki Ohyama¹

¹ Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama 226-8503, Japan

² Health Information Security Performance Rating Organization, 2-9 Sakuragaokacho, Shibuya, Tokyo 150-0031, Japan

Keywords: Electronic Health Records, PHR, e-Post Office Box, Health Card, Healthcare Management System.

Abstract: We introduce e-Post Office Box system which renders individuals their personal information management and safe access through the Internet to share and utilize their personal information under their own control. We have developed a personal health information management system based on the e-P.O.Box conception. All the personal information dealt in the system is securely protected in the network complying with the government guidelines for safety management of medical information systems. The system is connected with medical institutions using on-demand VPN and, the access to it is securely guarded by the use of IC card. We conducted a field experiment for the evaluation of the developed system with the staffs of Tokyo Institute of Technology and doctors in a hospital, simulating the cases of clinical consultation of patients with some adult disease. The experiment confirmed the effectiveness of the system for the patients.

1 INTRODUCTION

In the healthcare field, it is important to compile the healthcare information into a database to share and utilize it. So far, healthcare information sharing has been discussed on the viewpoint of community medicine cooperation and statistics, and several experiments have been done in some areas. However, information sharing on the viewpoint of individual-centric and self-healthcare management is just the beginning stage of discussion. To record personal health data for the lifetime requires many complicated access control with various limitations on privacy protection. Meanwhile, individual-centric self-healthcare management system provides communication tool for the patient to convey precisely his state to healthcare staffs, and it has the effect of eliminating unnecessary or redundant clinical trials reducing the burden of the patient. In addition, the system furnishes patient episodes of pre and post-hospital care, medical certificate, and referral letters online. It also makes medicines information including prescription managed by

patient himself, and is effectively used as a healthcare consultation tool.

We introduce e-Post Office Box (e-P.O.Box) system which renders individuals their personal information management and safe access through the Internet to share and utilize their personal information under their own control. The concept was at first proposed in the meeting of IT Strategic Headquarters of Japanese government Dec. 2006, and adopted in the Priority Policy Program 2007. The e-P.O.Box project had been supported by the Cooperation of the Cabinet Secretariat, Ministry of Internal Affairs and Communications (MIC), and Ministry of Health, Labor and Welfare (MHLW).

In the New Strategy in IT May 2010, "My Hospital Everywhere" (Japan's Personal Health Record service) policy was declared, of which the concept enables individuals to electronically manage and utilize their own medical and health-related information wherever they may be. Government is scheduled to start partial services based on the concept (management of medication and other records) by 2013, at the latest. In fact, "My Hospital

Everywhere" concept can be implemented by the application of the e-P.O.Box.

We developed a prototype of the e-P.O.Box Basic System applied to personal health information management system, whereby health information is delivered from medical institutions to the server, i.e. e-P.O.Box, for patient to manage his own. The patient can access to the server using his ID card, download his information, register other necessary information, and refer to them when required for the treatment or health maintenance from a medical institution or from home. We conducted a field experiment for the evaluation of the developed system with the staffs of Tokyo Institute of Technology and doctors in a hospital, simulating the cases of clinical consultation of patients with some adult disease. The experiment confirmed the effectiveness of the system for the patients.

2 CONCEPT OF THE E-P.O. BOX

The introduction of the e-P.O.Box is for the purpose of providing citizen's personal information to the citizen himself by governmental administrative and social security-related organization. All the e-Government services is expected to be converged through the e-P.O.Box aiming for one stop service, including the social security status check, national pension, health insurance, employment insurance etc. as well as healthcare service of private sector. Especially, if personal healthcare information added and managed, then e-P.O.Box functions as a PHR, and it can also include personal pharmaceutical information, such as e-Prescription and personal medication history.

It is just like a bank account through which people manage his monetary flow trusting the banking service provider. The use of the account is fully under the holder's control and the status could be checked at anytime. Every people in Japan including foreigner has resident registration is given a personal account of e-P.O.Box in the cyberspace. However, it is not mandatorily but by the voluntary application, which is for good social acceptance.

The e-P.O.Box account has a role of reliable point in the cyberspace trusted publicly and definitely tied to the user, like the address of home in the real world, of which the existence is registered in the local government. The cyber home position provides a method of certification and qualification of the user in public services, and the access to it is securely guarded by the use of IC card. The newly introduced Social Security Card is expected to be an

access card of the e-P.O.Box, the issuance covering resident aliens in Japan. Another candidate is the Basic Resident Register Card currently being used as an identification card. In this case, however, the card holder is limited to only Japanese nationality so far.

The e-P.O.Box seems at first glance to be similar to the portal sites and PHR (Personal Health Record) systems, which already exist in the Internet sites. In such systems, however, management of information flow is under the service provider's control, so users usually have 'windows' or 'gates' only to browse their information. Moreover, the existent services are separately provided by local governments, health insurers, and medical institutions. Protection of user's privacy is always a matter of great concern.

3 APPLICATION TO PHR AND MEDICATION HISTORY MANAGEMENT

A prototype of the e-P.O.Box System was developed in Tokyo Institute of Technology for personal health information management system. It consists of three parts, inBox, viewBox, and Concierge. The inBox has the function mainly to receive data from healthcare institutions. The viewBox is used to register, store, and refer the data in inBox. The Concierge is a bridge for cooperation with external services, which effectively utilizes the personal health data for the user. Fig.1 shows the schematic diagram of personal health information reference system. In this diagram, the part of the Examination Center is taken out of the laboratory and put in the hospital near Tokyo Tech to collect the medical examination data of users. For the upload from the hospital to the server, HPKI signature is used to confirm the potential authentication of the data.

The system adopts the Tokyo Tech ID card as an access IC card, which is issued to all the staffs and students of Tokyo Institute of Technology. The IC card has user authentication function by PKI (Public Key Infrastructure) technology, and is used for data encryption and decryption to guarantee a confidential communication. The electronic signature of doctor is generated using HPKI (Healthcare Public Key Infrastructure) and attached to the data to confirm the integrity and non-repudiation of it. The HPKI certificate is issued by MEDIS-DC (Medical Information System Development Center) in Japan.

The healthcare data dealt through the system are to be described in a unified form to share and

utilized effectively. As a standard format, we applied HL7 CDA R2 to the health checkup report. It is standardized in CDA SIG of HL7 Japan and adopted HELICS (Health Information and Communication Standards) Board of Japan. The health checkup report is converted to a document written in XML using data transformation software developed in Tokyo Tech.

The formally arranged document is added with metadata and packaged with appendant files before compression. The metadata contains concise information to make the contents of the document easily searched and managed effectively.

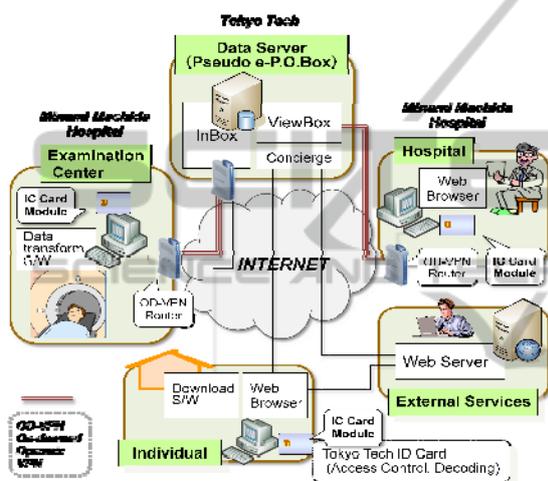


Figure 1: The schematic diagram of personal health information management system.

4 EXPERIMENT AND RESULTS

We conducted field trial experiment of the developed system with the staff and students of Tokyo Institute of Technology. For the experiment, The Tokyo Tech ID card is substituted for the access card of is the e-P.O.Box. The Tokyo Tech ID card has PKI function.

The workflow is as follow;

- (1) The medical examination data including diagnostic images and electrocardiograms, if any, are digitally signed by the doctors and sent to the account of the patient in the Examination Data Server, i.e. inBox of the prototype e-P.O.Box. The data pass through the OD-VPN(a Dynamic On-demand VPN) Router is encrypted by a secret key of symmetric key cryptography and the secret key is encrypted by patient’s public key and attached to the data 20).

- (2) The patient accesses to his account with authentication by his ID card, and download the data from the hospital. The secret key used in the encryption of the data is decrypted using his private key packed in the ID card.
- (3) The data is decrypted by the secret key. The medical examination data with digital signature of the doctor is securely registered in viewBox at patient discretion.
- (4) Dynamic On-demand VPN authenticates the sender to be a healthcare professional by HPKI and the connection control is performed by the policy.
- (5) By HPKI, the referring side of the data can confirm that it is provided by healthcare institution or by a source of the public responsibility.

To evaluate the developed system, we conducted a simulation of consultation referencing healthcare data in the field experiment in a hospital. In the experiment, we verified that whether the system was easily operated with several privacy protection installations, procedures of data acquisition and reference are adequate, and after all it was clinically effective or not. The problems occurring when individuals manage their own healthcare information were also investigated.

The patients participating in the simulation are supposed to have a symptom of adult diseases, such as hyperpiesia, diabetes, and arrhythmia. Doctors are given the explanation of security mechanism of the system to understand the significance of using the ID card. They can check the authenticity of patient data through verification of the electronic signatures knowing the name of institutions where the dada are originally produced. Doctors can confirm some of data are concealed by the patient, if any, for some reason of his privacy.

5 DISCUSSION

In the field experiment conducted in the hospital to evaluate the system, we confirmed the effectiveness of it in the consultation for the patients. Doctors gave precious comments to improve the system, especially about the user interfaces. Through the experiment, we have known that the system provides a good tool to share the healthcare data securely among medical institutions. It also makes it possible for people manage his own health data under his control, which is one of the main purposes of the system.

The system complies with governmental network security management guideline for health information system by using the dynamic on-demand VPN technology on the Internet.

In the near future, we are going to conduct another experiment of actual service for a group of staffs and students of Tokyo Institute of Technology with newly developed pseudo-electronic prescription function. The function enables patient to manage his medication history, as well as daily measuring data such as blood pressure, weight, and caloric intake.

Technical aspects for uncommon uses of the system are under study. They include handling emergency cases with unconscious patients. The access of patient data by a legal representative or guardian has also to be considered for children or people who do not have an ability to manage his data. Preparing for the case when patient cannot use his access card anymore by loss or fault of it is necessary as well.

For the real service using the system, participation of as many medical institutions as possible is inevitable. However, it requires multifaceted incentives for the participant hospitals. This is thought to be one of the most crucial factors for widespread public use of the system.

To spread the system for the public use, who pay the cost of the system is one of the most significant considerations in the future. It sounds reasonable that the sender of the information bears the cost. Other data such as EHR could be treated in the e-P.O.Box box at the user's choice, even more life event such as employment, retirement, graduation, move, etc. could be included with a good navigation of the Concierge function. The more widely used, the less expensively it would costs.

The access method of the system is another key factor for the diffusion of the system. The adoption of various terminals, such as Mobile phone and kiosk terminal, is being considered as the candidates. Access through the digital TV for terrestrial broadcast that wholly starts from Jun. 2011 is also under discussion. It is from the perspective of dissolving digital divide and providing universal service for the people who are not familiar with using computer.

REFERENCES

Priority Policy Program 2007, from: <http://www.kantei.go.jp/foreign/policy/it/Program2007.pdf>. Accessed August 28, 2008.

A New Strategy in Information and Communications Technology (IT) May 11, 2010, from www.kantei.go.jp/foreign/policy/it/100511_full.pdf

Takeda H., Matsumura Y., Kuwata S., Nakano H., Sakamoto N., Yamamoto R., (2000). Architecture for networked electronic patient record systems. *Int J Med Inform* 60(2):161-167.

Application service of HPKI certificate in MEDIS-DC. from: http://www.medis.or.jp/8_hpki/index.html. Accessed September 4, 2008.

Kita K., Hirai M., Suzuki H., Yachida M., Yamaguchi M., Obi T., Ohyama N., (2007). The personal health data referring system conforming to a health checkup report standard for personal use based on CDA R2; *The 27th Joint Conference on Medical Informatics*.

Joong-Sun Lee, Hiroyuki Suzuki, Naoko Taira, Kouichi Kita, Takashi Obi, Masuyoshi Yachida, Hiroshige Yamamoto, Yuji Homma, Masahiro Yamaguchi, Nagaaki Ohyama, Masataka Inokuchi, (2009) Development and Field Evaluation of the Personal Health Information Reference System based on e-P.O.Box Conception, *The 6th Conference of Asia-Pacific Medical Informatics Association (APAMI2009)*, P-04.