SFRP
Société Française de Radioprotection

Available online at:
www.radioprotection.org

Implementing eHealth with radiation records: a new support package for evacuees returning to areas around the Fukushima Daiichi nuclear power station

T. Ohba[1,a,*], A. Goto[1], H. Nakano[1], K.E. Nollet[1], M. Murakami[1], K. Yoshida[1,2], Y. Yumiya[1], K. Honda[1], Y. Kuroda[1], A. Kumagai[3], T. Ohira[1] and K. Tanigawa[4]

[1] Fukushima Medical University (FMU), Fukushima, Japan.
[2] Iryo Sosei University (ISU), Iwaki, Japan.
[3] National Institutes for Quantum and Radiological Science and Technology (QST), Chiba, Japan.
[4] Futaba Medical Centre (FMC), Futaba, Japan.

Abstract – Following the 2011 Fukushima Daiichi nuclear power station (FDNPS) accident, numerous initiatives emerged to address the needs of evacuees, including those eligible to return home. These came from multiple channels, timely in many cases, but in retrospect, needing better coordination. By embracing eHealth, we are attempting to coordinate efforts in Fukushima intended to link returnees with health information and care providers, not only for radiological protection in particular, but also for health promotion in general. We aim to establish a comprehensive support system for residents in municipalities around the FDNPS by developing a digital application for interactive communication regarding radiation and health promotion and to link the tool to other resources provided by local health care providers and radiation specialists. This paper explains the progress of our innovative trial to introducing eHealth in areas affected by the FDNPS accident. Based on international recommendations for developing a digital tool in response to a nuclear accident, we designed a comprehensive support package including development and implementation of the application, data management, and health counselling and ethical considerations arising from such outreach. Our trial of connecting disaster-affected citizens to health services using informatics could serve as a model eHealth program for long-term restoration after a nuclear accident.

Keywords: eHealth / evacuees / Fukushima nuclear accident / health promotion / radiation protection

1 Introduction

As decontamination progressed in areas affected by the 2011 Fukushima Daiichi nuclear power station (FDNPS) accident, the Japanese government started lifting evacuation orders and restoring infrastructure. Municipal offices, along with academic, professional, and citizen organizations started offering support for returning evacuees. Among many projects, Fukushima Medical University (FMU), 56 km from FDNPS, launched a prefecture-wide health survey coupled with risk communication and health promotion activities, and a coastal hospital closer to the nuclear plant collaborated with local governments to offer whole-body counting and personal dosimeters to facilitate residents' understanding of radiation

exposure (Murakami *et al.*, 2017). Moreover, Nagasaki University opened satellite facilities in Fukushima prefecture and concluded a collaborative agreement toward reconstructing returnees' life (Takamura *et al.*, 2016). Also noteworthy was that a citizens' group started its own activities to measure environmental radiation, aiming to guide autonomous decision making about daily activities (Ando, 2016). They also started dialogue meetings to discuss matters of daily life with domestic and international professionals (Schneider *et al.*, 2019). These comprise just some of the services for evacuees provided through multiple channels, implemented by different organizations, and supported by various funding sources. As the average age of returnees is higher than that of the entire cohort of evacuees, attention to their psychological and socioeconomic status (Murakami *et al.*, 2019) is necessary to help them express their own needs and accept support.

The European Union (EU) "SHAMISEN-SINGS" project started to explore ways to develop and utilize mobile digital tools to promote citizen participation in long-term recovery

*Corresponding author: tohba@fmu.ac.jp
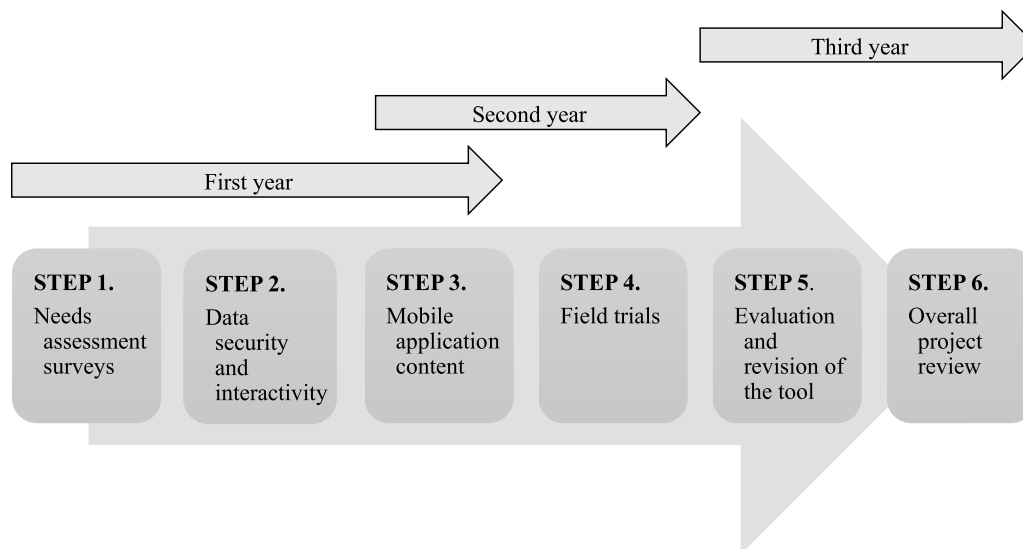[a] Present address: 1 Hikarigaoka, Fukushima City, Fukushima, 960-1295, Japan.

Fig. 1. Our project of six processes during three years from JFY 2019 to 2021. In the first year, we have performed our research in step 1 to a half of step 3. In the second year, we will go through our process in step 3 to step 4. In third year, we will move to step 5 and step 6.

after a nuclear accident (ISGlobal, 2017). The project developed recommendations to build strong relationships and timely information exchange among local stakeholders and affected populations during the early and long-term consequences of a radiation accident. Such a project is in line with the recent promotion of eHealth, generally defined as the "use of information technology in the delivery of health care" (Oh *et al.*, 2005). In 2019, the World Health Organization published a guideline on digital interventions to strengthen health systems (WHO, 2019). They state that digital interventions can cohesively address health system needs by interlinking information and people. Clients should be able to access health information and services in a timely manner through improved data sharing and communication with their service providers. Such eHealth promotion can contribute to Goal 3 of the United Nation's sustainable development goals (SDGs), which includes improving access to quality health care (WHO, 2018).

Therefore, introduction of eHealth in the Fukushima communities most affected by the FDNPS accident is a promising method to link returnees with health care providers and other professionals more efficiently for the purpose of ongoing radiological protection and health promotion. Building on the above-mentioned EU project in which our research team participated, we launched a project to develop a mobile application adapted to local needs and to establish a comprehensive support system utilizing the developed tool. This paper describes how we developed a blueprint for the application and support system.

2 Materials and methods

With funding from Ministry of the Environment, Government of Japan (MOE), we initiated a risk communication project with a team consisting of five physicians in various specialties, three nurses (one nurse and two public health nurses), a radiation technologist, a medical informatics specialist, a clinical psychologist, a risk communication

specialist, and an anthropologist. Team members were selected to develop a key digital radiation and health information package to facilitate interactive communication among returnees and local health workers such as public health nurses, social workers, hospital staffs, and municipal radiation consultants. Our three-year project includes the following 6 steps (Fig. 1):

– needs assessment surveys;
– data security and interactive system;
– mobile application content;
– field trials;
– evaluation and revision of the tool;
– overall project review.

An application blueprint emerged during the first three steps, guided by eight recommendations published by the EU project (ISGlobal, 2017):

1 Optimise well-being assessment indicators with relevant stakeholders;
2 Balance content, security, and development cost;
3 Develop a team to support the app users;
4 Apply incentives to promote application use;
5 Include questions and answers on health effects and mitigation of radiation exposure;
6 Involve vulnerable populations (children, pregnant women, and the elderly);
7 Accommodate multiple languages for immigrant workers and travellers from abroad;
8 Consider ethical issues related to the application use, especially privacy protection.

Herein we review and summarize the project framework that emerged in roundtable discussions among project members during the first three steps. The project started in October 2019, guided by four subsequent meetings about detailed research plans, application development policies,
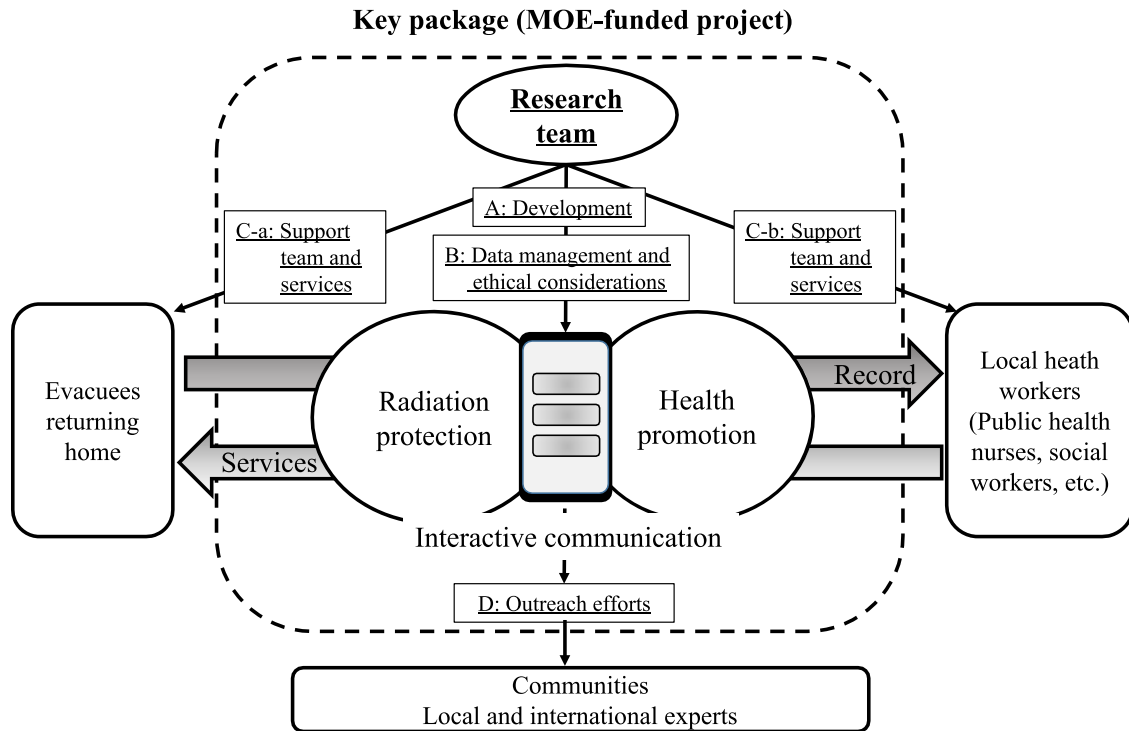
Key package (MOE-funded project)

Fig. 2. Project framework to explain our comprehensive key package for the support system integrated evacuees returning home with local health workers. Our research team will develop the radiation protection and health promotion package using a mobile phone application tool.

content, data management, ethical issues, and implementation of related activities including needs surveys and interviews.

3 Results and discussion

Figure 2 shows the four major components in our key package: (A) the development of a mobile application including radiological protection and health promotion items; (B) the data management system for sharing information among returnees and health workers, with careful ethical and privacy protections; (C) the development of a support team for health workers to utilise our application effectively in their fieldwork; and (D) further outreach not only to expand the user base and impact in local communities, but also to increase credibility among local and international experts.

As for components A and C, Table 1 shows major items included in the application and its usage in the field. We identified users of these tools as public health nurses, social workers, and other professionals involved in supporting returnees' daily lives. There are 3 supporting functions in our application: radiation records, health records, and responses. This is to better share information on radiation contamination, which is reported to be low even in the former evacuation zones (Nomura *et al.*, 2020), and also to facilitate health promotion. In radiation record mode, at the first level, our application automatically estimates annual dose using collected data. At the second level, it can automatically reply with advice prepared in advance. At the third level, users can access the detailed radiation information resources. These include the MOE-published "Information Booklet for Returnees" and "Booklet to Provide Basic Information Regarding

Health Effects of Radiation" (MOE, 2017, 2019), which help returnees and local health workers to think and act together about ways to improve their lives. In health record mode, at the first level, users enter personal biometric data and daily health practices. At the second level, the application can generate automatic graphs of entered data trends and offer advice. At the third level, users can check detailed health information sources including reports from the prefecture-wide Fukushima Health Management Survey (Fukushima Prefecture, 2012; Yasumura *et al.*, 2012; Goto *et al.*, 2018).

Moreover, as shown in Table 1, we are aiming to combine the application with a support system for public health nurses and other local health professionals to communicate with returnees about the data collected and shared through the application. Residents can enter data and request consultations, which will be sorted and forwarded to the professionals to effectively connect people with the services they need. Our technical support will be two-fold (Fig. 2C − a and b). First, we plan to meet face-to-face with elderly returnees who are unfamiliar with the usage of smartphones and applications (Fig. 2C − a). This effort will proceed hand-in-hand with the application's development company, which is locally based and well experienced in distributing health promotion digital tools in Fukushima Prefecture. Second, we will support health workers who enter returnee information on their behalf (Fig. 2C − b). Our developing application is a medium for recording and sharing information on radiation exposure and health, and our idea is to establish a secure system that allows not only returnees but also qualified family members and health workers to enter their information. In cases where returnees cannot physically connect to the internet, it is possible for health workers to input their information after

Table 1. Application content to combine the application with a support system for public health nurses and other local health professionals to communicate with returnees about the data collected and shared through the application.

Major categories	Specific items	Responses[*]
Radiation items		
Ambient dose	Geographic location	1. Automatic estimation of annual dose for external and internal
External dose	Personal dose monitor	2. Automatic replies with advice
Internal dose	Food contamination level	3. Links to online resources
		4. Interactive consultation with radiation specialists
Health items		
Anthropometry	Height, weight, BMI	1. Personal biometric data and daily health practices
Medical measures	Blood pressure, blood sugar level	2. Automatic presentation of data trends
Health behaviors	Exercise, sleep, alcohol consumption, smoking	3. Link health information sources
Mental health	Dairy of daily feelings, socialization	4. Interactive consultation with health specialists
Medicine	Medication record	

[*] Support team of the application includes physicians, nurses including public health nurses, a radiation specialist, a clinical psychologist, a medical informatic specialist, and a risk communication specialist. The team collaborates with public health nurses and other local health professionals at local governments and health facilities, who provide support for returnees.

hearing directly from a resident when providing services. Exploring this multifaceted use of our developed tool itself would be a worthwhile research question to explore during the field piloting phase following the development phase.

It should be noted that the data stored by the application will be anonymized and personal information will not be retained on individual devices. The aggregated data will be stored in a secure cloud that can be accessed by designated staff at each field trial institute via an access-controlled ID and password. For data sharing among the health workers and the research team, we will obtain informed consent from the returnees. As illustrated in Figure 2B, the data stored in the application will not only serve individuals but also will be aggregated at the community level to serve broader social goods.

Our application should improve outreach efforts to local governments and relevant health workers as shown in Figure 2D. In particular, our outreach efforts will be promoted to local governments in the former evacuation zone around the FDNPS as an option to support to the needs of returnees in these municipalities. The application has the potential to deliver reliable support from health workers to returnees with less individual effort for common issues, leaving more time to address unique concerns. It should be emphasized that our purpose is not to have returnees or health workers test an application, but rather, to enhance the support of returnees by health workers backed by trustworthy human and material resources.

Among the aforementioned eight EU guidelines, (2) *Balance content, security, and development cost is*, at this juncture, at odds with (7) *Accommodate multiple languages for immigrant workers and travellers from abroad* (ISGlobal, 2017). Ideally, different languages could be user-selected from a range of options that could be updated and validated by field workers, with no additional involvement of application software writers. Alternatively, if cost considerations lock us into a limited language set, a partial solution would be to add

health-related icons to textual descriptions of user input functions (Wolk *et al.*, 2017). Another aspect of cost pertains to maintaining compatibility with ever-evolving operating systems and hardware. Even if such evolution is backward compatible with applications such as ours, without an ongoing development budget, we are at risk of having, in short order, a quaint "legacy system" of limited functionality, in which our intended users will progressively lose interest.

Our digital tool, if developed by responding appropriately to returnees' needs and utilized in collaboration with those who support them, would provide a mechanism for returnees to identify and express their own needs and be connected more efficiently with radiation and health professionals. Our trial of connecting disaster affected communities, health services, and informatics would serve as a model eHealth program for long-term restoration after a nuclear accident. Digital tools such as ours have a potential to improve utilization of limited human resources in health care to meet the complex health and daily living needs of returnees.

Acknowledgements

Conflicts of interest. The authors declare that they have no conflicts of interest in relation to this article.

References

Ando R. 2016. Measuring, discussing, and living together: lessons from 4 years in Suetsugi. *Ann. ICRP* 45: 75–83.

Fukushima Prefecture. 2012. *Fukushima health management survey.* Available from http://kenko-kanri.jp/en/health-survey/#sec-report.

Goto A, Lai AY, Kumagai A, Koizumi S, Yoshida K, Yamawaki K, Rudd RE. 2018. Collaborative processes of developing a health literacy toolkit: a case from Fukushima after the nuclear accident. *J. Health Commun.* 23: 200–206.

ISGlobal. 2017. *SHAMISEN-SINGS project.* Available from https://radiation.isglobal.org/shamisen-sings/.

MOE. 2017. *Information booklet for returnees.* Available from https://www.env.go.jp/chemi/rhm/shiencenter/pdf/kurashinotebiki.pdf (Japanese).

MOE. 2019. *Booklet to provide basic information regarding health effects of radiation.* Available from https://www.env.go.jp/en/chemi/rhm/basic-info/.

Murakami M, Sato A, Matsui S, Goto A, Kumagai A, Tsubokura M, Orita M, Takamura N, Kuroda Y, Ochi S. 2017. Communicating with residents about risks following the Fukushima nuclear accident. *Asia. Pac. J. Public Health* 29: 74S–89S.

Murakami M, Takebayashi Y, Tsubokura M. 2019. Lower psychological distress levels among returnees compared with evacuees after the Fukushima nuclear accident. *Tohoku J. Exp. Med.* 247: 13–17.

Nomura S, Murakami M, Naito W, Yasutaka T, Sawano T, Tsubokura M. 2020. Low dose of external exposure among returnees to former evacuation areas: a cross-sectional all-municipality joint study following the 2011 Fukushima Daiichi nuclear power plant incident. *J. Radiol. Prot.* 40: 1–18.

Oh H, Rizo C, Enkin M, Jadad A. 2005. What is eHealth (3): a systematic review of published definitions. *J. Med. Internet. Res.* 7: e1.

Schneider T, Maître M, Lochard J, Charron Lecomte J-F, Ando R, Kanai Y, Kurihara M, Kuroda Y, Miyazaki M, Naito W, Orita M, Takamura N, Tanigawa K, Tsubokura M, Yasutaka T. 2019. The role of radiological protection experts in stakeholder involvement in the recovery phase of post-nuclear accident situations: some lessons from the Fukushima-Daichi NPP accident. *Radioprotection* 54: 259–270.

Takamura N, Taira Y, Yoshida K, Nakashima-Hashiguchi K, Orita M, Yamashita S. 2016. Communicating radiation risk to the population of Fukushima. *Radiat. Prot. Dosimetry* 171: 23–26.

WHO. 2018. *Sustainable development goals (SDGs).* Available from https://www.who.int/reproductivehealth/publications/digital-interventions-health-system-strengthening/en/.

WHO. 2019. *WHO guideline: recommendations on digital interventions for health system strengthening.* Available from https://www.who.int/sdg/en/.

Wolk K, Wolk A, Glinkowski W. 2017. A cross-lingual mobile medical communication system prototype for foreigners and subjects with speech, hearing, and mental disabilities based on pictograms. *Comput. Math. Methods Med.* 2017: 4306416.

Yasumura S, Hosoya M, Yamashita S, Kamiya A, Akashi M, Kodama K, Ozasa K. 2012. Study protocol for the Fukushima Health Management Survey. *J. Epidemiol.* 22: 375–383.