

Review

Reviewing Domestic Literature on Radiation Emergency Medicine: Role of Nurses as Viewed in the Literature

Hikaru Sasatake*, Maiko Kitajima, Mayumi Urushizaka and Yuka Noto

Department of Nursing Science, Hiroasaki University Graduate School of Health Sciences, 66-1 Hon-cho, Hiroasaki Aomori 036-9564, Japan

Received 1 March 2017; revised 2 April 2017; accepted 24 April 2017

This study was to investigate previous researches on nurses' roles in radiation emergency medicine (REM) in Japan and to clarify how much is known on this subject. These 178 publications that were the target of the analysis were classified by the type of literature, their publication date, and the period in which they were published and then the number of publications was confirmed. Moreover, the subjects were classified after the content that was described. Besides the past nursing publications, nursing professionals have been included in training and practice for REM, have been given education, and have been included in the staff members who are on the REM team. However, there have not been any details or records of the roles of nursing professionals. It seems possible to clearly specify the roles of nurses in REM by accumulating more studies going forward. Moreover, once the nursing roles have been clarified and shouldered, clarifying the type of human resources that are required and the type of training to be conducted and education to be provided is essential. By reviewing and changing the existing system based on cases of past accidents and disasters, the roles of nurses that are required by their medical institutions will become clear.

Key words: Radiation emergency medicine, nurse, role, systematic review

1. Introduction

The Fukushima Daiichi nuclear power plant accident in 2011 caused widespread awareness of the importance of emergency care for radiation exposure. During the accident, some nurses were active as members of the radiation emergency medicine (REM) team. The REM was provided, and the role of nurses in the team was considered to be significant. After the accident, this team had to respond to the health problems of the people that resulted from the radiation exposure and

contamination. Therefore, nurses are required to learn fundamental and specialized knowledge and techniques related to radiation. However, basic nursing education does not provide sufficiently advanced knowledge and skills for radiation exposure, protection, prevention of contamination, and other measures, which are required for the radiation emergency medicine (REM). Continuing education also provides few opportunities for such learning; and thus, presently, knowledge and skills on the REM are insufficient. Moreover, incidents that require REM occur extremely rarely. At the present, REM education is fragmented, and knowledge on this subject has not sufficiently accumulated. Therefore, REM experience during the Fukushima Daiichi nuclear power plant accident is valuable. Based on this experience, a development of on-site REM system has just begun.

*Hikaru Sasatake: Hiroasaki University Graduate School of Health Sciences, 66-1 Hon-cho, Hiroasaki Aomori 036-9564, Japan
E-mail: sasatake@hirosaki-u.ac.jp

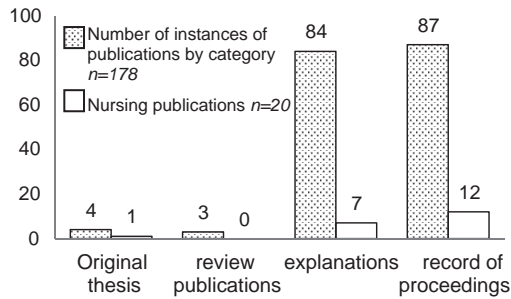


Fig. 1. Number of publications by category.

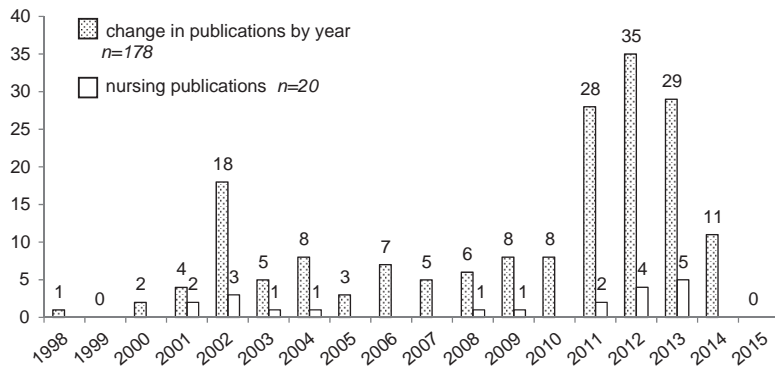


Fig. 2. Change in number of publications by year.

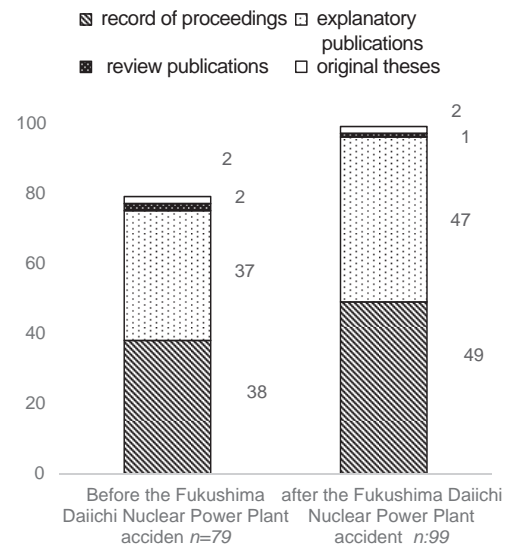


Fig. 3. Comparison of the number of publications from before to after the Fukushima Daiichi Nuclear Power Plant accident.

However, reports on such experience are limited.

We will examine reports, discussions and examinations on the REM, and activity reports of nurses who have performed REM through literature review. From the present discussions and examinations of REM and nursing practice, new understanding on the roles and expected roles of nurses in REM can be obtained.

2. Objective

The objective of this study is to examine the contents of discussions and examinations on the REM and reports and examinations on nursing practice in Japan.

3. Methods

Definition of terms

In this study, we define REM as “a medical care for individuals who are or might have been exposed to radiation and contamination by radioactive materials.”

3.1. The Selection of Publications that are the Target for the Analysis

In order to elucidate what kind of studies on the REM have been published in Japan, especially within information sources that are commonly used by medical professionals, we used The Japan Medical Abstract

Society Web (Ver. 5). The Japan Medical Abstract Society Web (Ver. 5) summarizes Japanese medical papers, and allows searching 10 million papers from 6,000 medical, dental, pharmaceutical, and nursing journals. Following JCO criticality accident in Tokai Village of 1999, a medical care for victims with radiation exposure and contamination is called REM, and the REM system has been developed. Based on this process, we chose the keyword of “REM,” and searched the literature with a filter term of “human”. We did not limit the publication date as of August 2015. This yielded 251 search results, and the target of the analysis were the 178 search results that resulted from excluding publications where the subject of the abstract or text was concerning cells/biological impacts, the pharmacokinetics of drugs, tests, assessments of radiation levels and burns.

3.2. Analytic Method

We first classified 178 cases by the type of publication, then by the time period. The time period refers to two events: 1999 JCO criticality accident in Tokai Village, which was the first turning point for the REM, and 2011 Fukushima Daiichi nuclear power plant accident, which led to a reconsideration of nuclear disaster measures. To classify the contents, we prepared a coding sheet with the following items: title, author, journal, type of literature, keyword, study subject, summary of the paper, and

Table 1. Number of different types of nursing publications by where they were published $n=20$

Name of academic journal	Publication classification	Record of proceedings	Explanations	Review publications
Publication Journal of Japan Society of Disaster Nursing		5	1	
Best Nurse			1	
The Journal of Radiological Nursing Society of Japan			1	
Nursing Research				1
Collection of Lectures from The Academic Conference of Japan Academy of Nursing Science		1		
Japan Society of Cancer Nursing		1		
EMERGENCY CARE			2	
Japan Society of Nursing Research		2		
The Japanese Red Cross Society of Nursing Science		1		
Japanese Red Cross		2		
Quality Nursing			1	
Emergency Nursing			1	
Total		12	7	1

Table 2. Number of original theses by the academic journal that published the target theses $n=8$

Name of academic journal	Number of publications
Japanese Journal of Disaster Medicine	3
Journal of the National Institute of Public Health	1
Total	4

suggestions for nursing. After perusing the literature, we summarized the contents, and assigned category and subcategory names to them based on differences and similarities of the contents. Relevance and consistency of the content classification, categories, and subcategories were discussed by four people (researchers) who teach radiological nursing. For the content classification, we extracted and discussed the descriptions on the nursing practices and roles in REM.

4. Results

When publications were classified by type, it resulted in 4 original theses, 3 review publications, 84 explanatory publications, and 87 records of proceedings (Fig. 1). The change in the overall publishing of the target publications for each year (Fig. 2) was that it increased from 1 publication in 1998 to 18 publications in 2002. From 2003 until 2010, it changed to single digits. Then in 2011, this number increased to 28 publications; in 2012, it increased to 35 publications; in 2013, there were 29 publications. In 2014, the number of publications decreased to 11, and there have no publications as of September 2015. Of the 178 target publications, there were publications that had descriptions related to the activities of nursing professionals in REM (called nursing publications). The change in these publications starting in 2001 is as follows: from 2001 until 2004, there were 7 publications; from 2008 until 2009, there were 2 publications; and from 2011 until 2013, there were 11

publications. Furthermore, there were 79 publications before the Fukushima Daiichi nuclear power plant accident that were unrelated to the accident (publications from 1999 until July 2011 will be considered to be before the accident publications). There were 99 publications (called after the accident publications) after the Fukushima Daiichi nuclear power plant accident (Fig. 3). There were 20 nursing publications (including nursing journals), and when these were classified by type there was 1 original thesis, 7 explanatory publications, and 12 records of proceedings (Table 1). There were 12 journals that published nursing publications, and the Publication Journal of the Japan Society of Disaster Nursing published the most number of publications (6 publications) (Table 2). The number of original nursing publication theses by publication is as follows: 3 publications in the Japanese Journal of Disaster Medicine and 1 publication in Journal of the National Institute of Public Health (Table 2). The result of classifying the subjects of these publications was that they were classified into five categories comprising 14 sub-categories and other. The results as well as a classification by the time period in which publications were published are shown in Table 3. Subject classification categories are indicated by << >> and simple categories are indicated by < >.

The category “national and regional system” relates to the examination and development of the REM system at national and regional level. “Facility system” relates to the examination and development of the REM system in each medical facility. From each of these two categories, three

Table 3. Number of publications by subject classification *n* = 178

Category	Sub-category	Number of publications	
		Before the accident (%)	After the accident (%)
Systems at the national and local levels	Response Mechanisms and Systems	26 (33)	30 (31)
	Preparations (commodities, environment, human resources, training)	3 (4)	5 (5)
	Roles	4 (5)	5 (5)
Systems at the institutional level	Response Mechanisms and Systems	13 (16)	7 (7)
	Preparations (commodities, environment, human resources, training)	2 (2)	3 (3)
	Roles	1 (1)	2 (2)
Training	Construction and assessment of training programs	8 (10)	9 (9)
	Training plans and methods	3 (4)	1 (1)
Knowledge and Techniques	Knowledge about Care for Radiation Exposure	7 (9)	5 (5)
	Techniques like decontamination etc.	0 (0)	4 (4)
	Other (stable iodine tables and their directions for use)	1 (1)	0 (0)
Only activity reports	Accident response activities	2 (3)	21 (21)
	Participation in practice	2 (3)	1 (1)
	Things other than accident response activities and participation in training	3 (4)	0 (0)
Other		4 (5)	6 (6)

subcategories were extracted: 'mechanism and system of the measure,' 'provisions (materials, environment, human resources, and education),' and 'roles.' "Education" refers to REM education, and two subcategories were extracted from it: 'development and evaluation of educational program' and 'methods and means of education.' "Knowledge and skill/technology" relates to the basic and professional knowledge and skills on the REM, and three subcategories were extracted: 'knowledge on the REM,' 'technology such as decontamination,' and 'others (preparation and use of stable iodine).' The category "activity report" refers to the report on REM practices or REM training activities during a quiet period. From this category, three subcategories were extracted: 'accident response activities,' 'training participation,' and 'activities other than accident response activities and training participation.' Finally, those that could not be classified into any of above five categories and 14 subcategories were classified as "others."

The percentage of publications by category before the accident was as follows: 42% were <<national or local level systems>>, 20% were <<institutional systems>>, 14% were <<training>>, 10% were <<knowledge and techniques>>, 9% were <<activity reports>>, and 5% were <<other>>. The percentage of publications by category after the accident was as follows: 41% were <<national or local level systems>>, 12% were <<institutional systems>>, 10% were <<training>>, 9% were <<knowledge and techniques>>, 22% were <<activity reports>>, and 6% were <<other>>.

4.1. Before the Fukushima Daiichi Nuclear Power Plant Accident

① << National or local level systems >>

There were 26 publications about <response mechanisms and systems>, 3 publications about <preparations (commodities, environment, human resources, or training)>, and 4 publications about <roles>.

The content of publications that were classified into <response mechanism and systems> was related to creating systems or networks that were not confined to a specific institution but rather were at a national or regional level. Yamashita reported¹⁾ included a description of the systems or manuals that were created in the review meeting for the investigation of the network for the REM. Igari reported²⁾ and Kawata reported³⁾ reviewed the existing medical care system based on past cases of accidents. They compiled the "way REM should be" in 2001 and described how the system was revised from a medical care system centered on people in the surrounding areas to a medical care system centered on the workers within the nuclear power plant facilities. Besides, nuclear, biological, and chemical (NBC) disaster prevention measures were also described. The content of publications that were classified into <preparations (commodities, environment, human resources, or training)> was related to preparations at local or national institutions; this content was specifically about the cooperation with related institution, support with tangible aspects, and the spread of knowledge. The content of publications that were classified into <roles> was related

to the roles that are required for each type of occupation at the national or local level. Akashi reported⁴⁾ stated that the roles required of doctors for radiation therapy were supplying knowledge and techniques. Besides, the roles of medical radiographers were described as carrying out training and educational sessions and a response when REM is given.

②< Institutional system >

The number of literatures in each subcategory was as follows: 13 for 'mechanism and system of the measure,' two for 'provisions (materials, environment, human resources, and education),' and one for 'roles.'

The content of publications that were classified into <response mechanism and systems> was related to creating systems or networks at a specific institution. Tominaga *et al.*⁵⁾ reviewed a management system based on the training at their facility for NBC counterterrorism measures, and established an in-hospital manual and developed a REM system at their hospital.

The content of <preparations (commodities, environment, human resources, or training)> was related to creating a manual or plans for patients' records or responding to contamination or high levels of radiation exposure as ways to prepare the institutions.

The content for <roles> was related to the roles at specific institutions, and this took the form of seminars, training or practice, the emergency storing of medical supplies, and the dispatching of specialists.

③< Training >

The number of literatures for each subcategory was as follows: 8 for 'development (evaluation) of educational program' and 3 for 'methods and means of education.'

The content of <constructing (and assessing) training programs> was related to training or the creation of training programs. Kodama reported⁶⁾ described the changes in knowledge, fear, necessities, interests, and independent initiatives before, during, and after the training seminar was held at the institution. Besides, it had content regarding training medical personnel for emergency radiation exposure and the training curriculum. The content of <training plans and methods> included training related to REM and training subjects or methods of improving training. Hayashi reported⁷⁾ described the simulation training subjects and methods. Besides, it reflected the practices of the institution.

④< Knowledge · Techniques >

There were 7 publications about <knowledge about care for radiation emergency medicine> and 1 <other> publication.

The content of <knowledge about care for radiation emergency medicine> was related to an overview and knowledge about care for radiation emergency medicine. Yamaguchi reported⁸⁾ described the special characteristics and important points to be considered for

radiation emergency medicine. Besides, the publication contained content about hygiene during transportation, types and the definition of radiation exposure, impacts on the human body, and the details about treatment. The content of Jin reported⁹⁾ under the category <other> included an introduction of stable iodine pills and an explanation of their dose and directions for their use.

⑤< Activity reports >

There were 2 publications about <accident response activities>, 2 publications about <participation in practice>, and 3 publications about <things other than accident response activities and participation in practice>.

The content of publications about <accident response activities> included the activities for a JCO criticality accident in Tokai village. Tokuyama reported¹⁰⁾ was the response given to people who were sick or injured from the JCO criticality accident in Tokai village. In addition, it included a study on the health impacts of the JCO accident on the citizens residing in surrounding areas. The content of the <participation in practice> included the training practices of the institution staff members. The content of the <things other than accident response activities and participation in practice> included reports that gave an introduction of workshops, talked about treatments for patients who were exposed to high levels of radiation, and initiatives taken for REM in the concerned institutions.

⑥< Other >

The number of literatures was 4, which were past accident case reports and literature reviews. Nagoya reported¹¹⁾ is a case of an accidental source of radiation and radiation exposure due to a hydrogen bomb experiment, and this publication was a literature review on REM.

4.2. After the Fukushima Daiichi Nuclear Power Plant Accident

①< National and local systems >

There were 30 publications about <response mechanisms and systems>, 5 publications about <preparations (commodities, environment, human resources, or training)>, and 5 publications about <roles>.

The content of publications that were classified into <response mechanism and systems> was related to creating systems or networks that were not confined to a specific institution but rather were at a national or regional level; this was more specifically about creating a system of scientific society organizations, the spread of knowledge, and the training and deployment of talented people. The content of publications that were classified into <preparations (commodities, environment, human resources, or training)> was related to the preparation of national or local institutions that was not confined to a specific institution. Takahashi reported¹²⁾ described

evacuation methods, the examination of facilities that accepted these people, and the setting up of a system that can handle medical care. Yamaguchi reported¹³⁾ was about the response provided based on the characteristics of the evacuees temporarily entering a disaster area. The content of publications that were classified into <roles> was related to the roles of all of occupations, and it was not confined to a specific institution but rather looked at the national or regional level; these publications described the training of medical professionals in REM and the participation in emergency medicine.

②< Institutional system >

There were 7 publications about <response mechanisms and systems>, 3 publications about <preparations (commodities, environment, human resources, or training)>, and 2 publications about <roles>.

The content of publications that were classified into <response mechanism and systems> was related to creating systems or networks at a specific institution. Hasegawa reported¹⁴⁾ described the creation of network for the emergency care for radiation exposure, the expansion of training, and nursing education that does not adhere to the existing framework. In addition, it included cooperation, the dispatching of specialists, and continued education. The content of publications that were classified into <preparations (commodities, environment, human resources, or training)> was related to the preparations of institutions. Yoshida reported¹⁵⁾ and Yamauchi reported¹⁶⁾ focused on the talented people who are sought after during the acute phase of a nuclear disaster. The content for <roles> was related to the roles at specific institutions. Tominaga reported¹⁷⁾ described the response of continued education by institutions that serve as places for emergency care for radiation emergency medicine. Tsutsumi reported¹⁸⁾ described healthcare for citizens.

③< Training >

There were 9 publications about <constructing (and assessing) training programs> and 1 publication about <training plans and methods>.

The content of <constructing (and assessing) training programs> was related to workshops as well as initiatives and the training of human resources in facilities in prefectures and areas where nuclear power plants have been constructed. The content of <training plans and methods> was regarding the planning and utilizing of an action guide for practicing disaster prevention for nuclear disasters.

④< Knowledge and Techniques >

The number of literatures for each subcategory was as follows: 5 for 'knowledge on the REM,' 4 for 'technology such as decontamination,' and one for 'others.'

The content of <knowledge about care for radiation emergency medicine> was related to the necessity of care for radiation emergency medicine. Besides, it

included an explanation of emergency care for radiation emergency medicine. The content of <techniques like decontamination> included the differences in the decontamination rate depending on the decontamination method, the methods for decontaminating radioactive materials from foods, and methods for preventing secondary radiation exposure.

⑤< Activity reports >

The number of literatures for each subcategory was as follows: 22 for 'accident response activities' and one for 'training participation.'

The content of <accident response activities> were the support activities performed by group organizations and the support given after the Fukushima Daiichi nuclear power plant accident to help people to temporarily return to their homes. This content included DMAT activities, screening the evacuees for radiation, and assessing their internal amount of radiation exposure. The content of the <participation in practice> included the details of the training of talented people for REM that was done at the institution.

⑥< Other >

The number of literatures was six. The content of these publications were as follows: an epidemiological study done after the Chernobyl nuclear power plant accident, an examination of nursing publications, and the development of a scale to measure the attitudes of nursing professionals regarding REM.

4.3. Publications related to nursing

Among literatures prior to the Fukushima Daiichi nuclear power plant accident, Tokuyama¹⁰⁾ reported the detailed experience of nursing aids to patients in JCO criticality accident in Tokai Village. Tokuyama discussed the necessity of acquiring professional and practical knowledge and skills for the REM and the importance of corporation of team medical care and other professionals, and a mental health care. Konishi^{19, 20)} used the JCO criticality accident in Tokai Village case to discuss a necessity of scientific assessment of radiation risks, respecting dignity of victims, and providing mental health care support. Obara²¹⁾ studied an educational effect of the REM and reported that when nurses are able to visualize the initial radiation treatment, their anxiety is reduced, enabling them to perform their job more actively. Nagoya¹¹⁾ reported on a Japanese literature review conducted in 2009, and stated that the role of nurses in the REM was not clarified. Among literatures published after the accident, Tsutsumi¹⁸⁾ discussed the role of nurses in support activities, details of actual activities, and challenges. Hasegawa¹⁴⁾ and Kamiya²²⁾ indicated the importance of incorporating REM in basic education for all healthcare professionals, and an unconventional education such as simulation education. In addition, it

included descriptions of the work of constructing of an institutional medical system for radiation exposure²³⁾, of the necessity of knowledge for risk communication²⁴⁾, of the general lack of knowledge about radiation, and of the central coordinating role in the cooperation of various professions. Yamauchi reported¹⁶⁾, which was an original thesis, described the role of nursing. This publication studied nurses and doctors that were active as members of the facility's REM team. Furthermore, it clarified the role of the leading nurses on the REM exposure team. It described the role of leading nurses on the REM team as requiring knowledge about REM, needing to make emotional considerations for the evacuees, and necessitating countermeasures against the anxiety of the staff that is dispatched to the disaster site.

5. Discussion

5.1. Trends in the literature that can be seen from their publication time period

The number of publications increased after the JCO criticality accident in 1999 and decreased three years later to single digits. Moreover, there was a sudden increase in the number of publications after the Fukushima Daiichi nuclear power plant accident in 2011; however, these numbers once again decreased after three years. Thus, in both cases, a decrease in the number of publications was observed approximately three years after the accidents. The JCO criticality accident in Tokai village occurred in a single facility, and patients were hospitalized in a specific medical institution due to radiation exposure. It is believed that the number of publications is limited to 18 even during peak times because the number of people who could publish the content of the initiatives taken and the cases of illnesses are limited. Based on the trends in the publication time period of the literature, there seems to have been an increase in research reports when the JCO accident occurred in Tokai village in 1999, when the Act on Special Measures Concerning Nuclear Emergency Preparedness was enacted in 2000, when the "On How Emergency Care for Radiation Exposure Should Be" was published in 2001, and when there are accidents or reforms to the system. This increase in the number of publications may have resulted from the need to transmit information that corresponds to the accidents or reforms to the system.

5.2. Trends in the literature that can be seen from their categories

After the accident, many publications included those of activity reports, fundamental knowledge, and processes like the progression and methods for measures like decontamination. Publications that were related to the system on a local or national level particularly had a lot

of content about the need to review the system and the challenges being faced. After the Fukushima Daiichi nuclear power plant accident, there was widespread radioactive contamination. Furthermore, a significant number of evacuees and many healthcare providers were involved. Environmental pollution was added to the concerns about the impact of the accident on human beings. Because this event went beyond expectations, it was difficult to respond to the situation in a manner similar to the emergency care for radiation exposure that had been done up to that point. Publications related to <<national or local systems>> comprised more than 50% of the total literature. It seems that publications calling for the reconstruction of the national system and each institution's system^{25–27)} increased because a proper response could not be provided using the existing system. Reviewing the past policies and creating a system that could be implemented for <<systems at the institutional level>> became essential. This was an unprecedented widespread compound disaster. Some institutions that were designated as medical institution for emergency radiation care ceased to function as they were affected by the disaster. Thus, the limits of being able to respond in only the affected areas became apparent. Accordingly, there must be a review of not only the areas with facilities related to nuclear power but also of the system and the widespread cooperative order that includes the local area, national area, and administration. Many people have noticed the necessity of the cooperation between many different professions, including specialist related to radiation. In the future, after a new system has been established, assessing whether REM is being done realistically and effectively will be essential. Considerations must also be made for how this assessment should be conducted. The Fukushima Daiichi nuclear power plant accident occurred due to the confluence of two disasters: a tsunami and an earthquake. Before the accident occurred, people were involved in disaster care and emergency care activities in response to the earthquake and the tsunami. Thus, the Fukushima Daiichi nuclear power plant accident caused a situation wherein people needed to be responsible for emergency medicine for radiation exposure^{28–29)}. Examining the Fukushima Daiichi nuclear power plant accident as a disaster, emergency care for radiation exposure can be considered to be as part of disaster care. It becomes apparent from Yoshida reported¹⁵⁾ that it is desirable for people involved with emergency medicine or disaster care to obtain the knowledge and acquire techniques related to emergency care for radiation exposure. Thus, <<training>> and <<knowledge and techniques>> related to emergency care for radiation exposure is necessary for all healthcare providers and not just facilities where it is deemed to be relevant. After the Fukushima Daiichi

nuclear power plant accident, many <<activity reports>> were sent out. As time passed, the content of publications shifted from activity reports to publications about issues, proposals, or the review of the system and its policies. The content of publications continuously changed over time because of the importance of the early dissemination of this hitherto unexperienced event in its unchanged form and because time was needed to generalize the analysis, examination, and assessment of the accident.

5.3. *Suggestions on the role of nurses*

Besides the past nursing publications, nursing professionals have been included in training and practice for REM, have been given education, and have been included in the staff members who are on the REM team. However, there have not been any details or records of the roles of nursing professionals. If the discussion is limited to nursing publications, the common roles that are necessary for nursing are obtaining knowledge and techniques²³⁾ and providing psychological support. However, the roles of nursing professionals that are deemed necessary for both accidents and disasters have not been established, and the content of training and practice sessions is dependent on each individual institution³⁰⁾. The roles of nursing professionals that have been uncovered from the experience of local accident within a facility related to nuclear power and their roles uncovered from the experience of an accident that was caused by a large-scale disaster share the common point of learning and being equipped with knowledge and techniques. In Yoshida reported²⁴⁾, published after the accident, the term “risk communication” was included; however, this term was nowhere to be found in publications before the earthquake disaster struck. Moreover, this describes providing psychological support to medical personnel and providing knowledge to medical professionals as one of the roles of nursing¹⁶⁾. There were 20 nursing publications from nursing journals. A significant number of nurses were involved in managing the Fukushima Daiichi nuclear power plant accident. They were also involved in coordinating with authorized personnel, offering psychological support to staff and handling the elderly, people with health issues, healthy people, young children, and pregnant woman. However, there are no reports or studies on this, and little expertise was accumulated from this. Furthermore, few studies have been conducted on the nursing that was done for REM. The content of nursing publications are descriptions based on practical reports about nursing and experiences, such as support activities, and no publications have generalized and clearly specified the roles of nursing professionals in providing REM. Upon examining 178 domestic literatures, although the number is limited, we found some suggestions on nursing.

The REM prior to the Fukushima Daiichi nuclear power plant accident mainly focused on the education on nursing aid for several victims suffering from radiation contamination and exposure. For nurses with little basic knowledge on radiation, acquiring basic and professional knowledge and skills for radiation is essential to perform the REM that rarely required. It is assumed that expected roles of nurses in REM were to acquire basic and professional knowledge and skills for radiation, to perform radiation protection and decontamination procedures, and apply their knowledge and skills for radiation for nursing aid such as preparing in-hospital manual for radiation-related incidents.

The Fukushima Daiichi nuclear power plant accident was a large-scale complex disaster. Nurses faced a situation beyond their knowledge and skills acquired in the REM education. The scale of the accident was huge and the REM institutions did not function. It required managing a large number of victims in the disaster. In addition to victims of radiation contamination and exposure, local residents who may be affected by radiation contamination and exposure were subjected to the REM. Not only cooperating with medical staffs within own hospital, but also cooperating with other organizations such as a fire department, police department, municipality, and other health facilities became necessary. In addition to provide medical care at their own facilities, there was a demand for nurses to go to the accident sites and work with supporting medical staffs from various locations. In the Fukushima Daiichi nuclear power plant accident, nurses were expected to take roles required in the emergency medicine and disaster medicine together with REM. Based on the basic concept of prioritizing life and maximum happiness of the greatest number, ability to choose patients with the most urgent needs among a large number of victims, to consider those vulnerable in disaster such as children, pregnant women, and seniors, to build a team with other organizations and professionals to work together, and to understand terminologies commonly used in the communication with other organizations and professionals are desired. For the REM, in addition to the traditional roles, there are expectations to provide mental supports to local residents who are or may be affected by radiation contamination and exposure, and to medical staffs who worry radiation contamination and exposure to them.

Before the Fukushima Daiichi nuclear power plant accident, REM education was implemented through training and workshop in limited hospitals and facilities in the prefectures with nuclear power plants. In the future, including the neighboring areas of nuclear power plants, REM training and learning should be implemented to prepare for immediate dispatch following an actual accident. Since there are a large number of nurses in a

hospital, their contribution is expected. To make the REM training and workshop effective learning opportunities, it is important to be aware of the nurses' roles in the REM. Furthermore, through future studies, roles of nurses in the REM need to be elucidated.

In this study, we used The Japan Medical Abstract Society Web (Ver. 5) which is commonly used by many healthcare professionals, and performed literature search with a single keyword of "REM". In the process of the literature search, we discovered that REM was discussed in various terminologies such as nuclear disaster and radiation disaster in the literatures published after the Fukushima Daiichi nuclear power plant accident. To gain wider knowledge of the REM, we must perform literature search with more keywords. Since the present study narrowed down to only one keyword and used single information source, there may be a bias in literature searched. Therefore, our limitation was lack of wider literature search on the REM.

6. Conclusion

In this study, we performed literature search with an objective to elucidate contents that were reported and examined on nursing practice and the REM in Japan. As a result of examining 178 literatures, five categories were extracted: "national and regional systems," "facility system," "education," "knowledge and technology," and "activity report." Extracted contents indicate the following roles of nurses:

1. To prepare for the REM, nurses should acquire basic and professional knowledge and skills for radiation, along with practical nursing aid skill.
2. To provide supports to local residents who are or may be affected by radiation contamination and exposure, and to medical staffs who worry radiation contamination and exposure to them.
3. To have ability to identify those in need of medical attention based on the concept of emergency medicine and disaster medicine, to consider those vulnerable in disaster, to build a team with other organizations and professionals, and to understand terminologies used commonly with other organizations and professionals.

Reports that described the necessity of training nurses about the knowledge related to radiation were scattered throughout the literature. The literature describes the roles of nurses in instances of emergency care for radiation emergency medicine when it is done for an individual in a single institution, but their systemic role has not been clarified. Nurses are indispensable for medical care during normal times. Creating knowledge by accumulating the nurses' activity reports is essential to clarify the important roles of nurses in emergency

care for radiation emergency medicine. Furthermore, scientifically publishing studies related to nursing and accumulating research reports is essential.

Conflict of Interest Disclosure

The authors declare that they have no conflicts of interest.

References

1. Yamashita S. International radiation exposure care cooperative molecular epidemiological studies and promoting radiation emergency medicine. *Nagasaki Medical Journal*. 2004;79:151–4. Japanese.
2. Igari K. Outlook for the nuclear industry in the 21st Century: On the system of radiation emergency medicine in Japan. *J Occup Health*. 2010;52:199. Japanese.
3. Kawata Y. The current state of and issues with the system of radiation emergency medicine: Radiation damage decisions made for the response during accidents. Report *On How Emergency Care for Radiation Exposure Should Be*. *Innervision*. 2002;17(6):6–11. Japanese.
4. Akashi M. The expectations for radiation emergency medicine and radiation therapy physicians. *J Radiat Res*. 2004;6(1):66. Japanese.
5. Tominaga T, Mayuko Y, Norio H, et al. A trial at the creation of a standardized chart for emergency care for radiation exposure for an early response. *AMS*. 2009;20(8):653. Japanese.
6. Kodama T, Obara H, Jinbo H, et al. St. Marianna University School of Medicine Hospital's Disaster Prevention Measure Council: A questionnaire survey from lecture students who had education in radiation emergency medicine at medical institutions for early radiation exposure. *J J Disast Med*. 2009;14(3):403. Japanese.
7. Hayashi H. Learning simulations for emergency and disaster medicine. The realities of Learning Simulations for disaster medicine: A simulation of radiation emergency medicine. *JAAM*. 2007;31(11):1543–7. Japanese.
8. Yamaguchi Y. The realities of radiation emergency medicine. *JSRT*. 2006;53(10):1127. Japanese.
9. Jin H. Radiation emergency medicine "knowledge base for emergency drugs": On practicing with stable iodine tablets for nuclear power disasters. The 51st Collection of Summaries of Speeches given at the Japanese Radiation Research Society's Conferences. 2008;74. Japanese.
10. Tokuyama N. The present and future of radiation nursing. Nursing for radiation emergency medicine: Experiencing nursing patients of the criticality accident. *JNCQ*. 2001;7(12):1057–69. Japanese.
11. Nagoya M, Nishizawa Y. Trends in domestic publications about radiation emergency medicine and the roles of nursing professionals. *JSNR*. 2009;32(3):321. Japanese.
12. Takahashi K. Disaster medicine. The current state of radiation emergency medicine. *Dokkyo J Med Sci*. 2012;39(3):231–40. Japanese.
13. Yamaguchi Y, Koido Y, Sakamoto T, et al. Fukushima nuclear power plant accident working group: Support for emergency and disaster medicine for the recovery process from the Fukushima nuclear power plant accident. *J J Disast Med*. 2012;17(1):150–9. Japanese.
14. Hasegawa A. It's not scary if you know about it! The response to radioactive disasters that you want to know about as an emergency

- nurse. The response by Fukushima Medical University's radiation emergency medicine group to the Fukushima Nuclear Power Plant Accident. *ECJ*. 2012;25(1):41–8. Japanese.
15. Yoshida K, Yamada K, Sato Y, et al. Simulation training for radiation emergency medicine at Fukushima Medical University. *J J Disast Med*. 2014;19(3):509. Japanese.
 16. Yamauchi M, Mikami J, Sato D, et al. Actual state of medical care support for radiation victims at Advanced Critical Care and Emergency Center, Hirosaki University School of Medicine Hospital, after the Great East Japan Earthquake and Fukushima Nuclear Power Plant accident, and problems to be solved. *J J Disast Med*. 2012;17(1):160–4. Japanese.
 17. Tominaga T. Returning to the origins of radiation emergency medicine, a message for the next generation: The current on-site responses and issues regarding Tokyo Electric's Fukushima Nuclear Power Plant Accident, radiation medicine research's on-site response and logistical support. *Mook medical science*. 2013;6:101–107. Japanese.
 18. Tsutsumi Y. Roles of nurses in radiation emergency medicine and future challenges -Through the activities of dispatching people to Fukushima prefecture. *JSDN*. 2011;13(1):206. Japanese.
 19. Emiko K (2003) Two values in the clinical management of radiological accident patient: A nursing perspective. *JSDN* 5(2):33–38. Japanese.
 20. Konishi E. Two values in the radiation emergency medicine: A nursing perspective. *JSDN*. 2002;4(2):43. Japanese.
 21. Kohara H, Kodama T, Jinbo H, et al. St. Marianna University School of Medicine Hospital's Disaster Prevention Measure Council: On how training for radiation emergency medicine should be in early radiation response medical institutions. *J J Disast Med*. 2009;14(3):379. Japanese.
 22. Kamiya K, Tanigawa K and Hosoi Y. Health risks from nuclear power accidents and risk communication. Radiation emergency medicine and the system for this care centered on the actions of tertiary medical institutions for radiation exposure. *IJCEM*. 2011;239(10):977–84. Japanese.
 23. Uezawa N. Disaster relief for families and cancer patients that can be done by registered nurses, the activities of registered nurses in radiation therapy for cancer and radiation emergency medicine during the Fukushima Nuclear Power Plant Accident, concerning the starting up of a medical care system for radiation exposure. *JSCN*. 2012;26:362. Japanese.
 24. Yoshida K, Nakajima K, Hiroshima Y, et al. Radiation emergency medicine for the radioactive contamination caused by Tokyo Electric's Fukushima Nuclear Power Plant Accident: Initiatives and issues attempting to create the nurses specializing in radiation nursing. *RNSJ*. 2013;1(1):37–42. Japanese.
 25. Hasegawa A. The system for radiation emergency medicine: Why didn't secondary medical institutions for radiation exposure care function as expected? *J J Disast Med*. 2014;19(3):404. Japanese.
 26. Akashi M, Tominaga T, Takahata T, et al. Radiation damage-from foundations and epidemiology to safety measures. Radiation Protection and safety measures: the current state and an outlook for radiation emergency medicine in Japan. *Nippon Rinsho*. 2012;70(3):469–74. Japanese.
 27. Shishido F. Trying to build back better medical care after the great earthquake disaster. System for radiation emergency medicine and future issues regarding and a response to Tokyo Electric's nuclear power disaster. *Surgery Frontier*. 2011;18(4):369–372. Japanese.
 28. Hirohashi N. The state of radiation emergency medicine "How to interact with radiation care as an emergency medical technician" Moving from DMAT to a radiation emergency medicine team based on the treatment experiences during the Fukushima Nuclear Power Plant Accident. *JSEM*. 2012;15(2):167. Japanese.
 29. Tominaga T. Radiation damage and medical care: What was able to be accomplished and what was not during the Fukushima nuclear power plant accident. Radiation Emergency Medicine during Tokyo Electric's Fukushima Nuclear Power Plant accident: Activities at off-site centers, Radiation emergency medicine during compound disasters. *Mook medical science*. 2012;5:23–8. Japanese.
 30. Hashiguchi N, Yamauchi K, Hamaguchi S, et al. Returning to the origins of Radiation emergency medicine, a message for the next generation: Training and guaranteeing talented people in radiation emergency medicine, on Shimane University's initiatives for care for radiation exposure taken after the Fukushima Nuclear Power Plant Accident, *Mook medical science*. 2013;6:85–91. Japanese.