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The existence of permanent facilities for nuclear disaster medicine progresses the development of manuals regardless of the years of designation elapsed

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Abstract – To ensure the quality of nuclear disaster medical care, facilities are being developed worldwide in the event of a nuclear disaster. However, the relationship between the existence of permanent facilities and the presence or absence of facility operation manuals has not been clarified in the field of nuclear disaster medicine. This study aims to determine the relationships between the existence of permanent facilities, the presence or absence of facility operation manuals and the number of years elapsed since a facility was designated for nuclear disaster medicine. In September 2021, 26 facilities responded to an online questionnaire of the 53 facilities of nuclear disaster-related hospitals (valid response rate of 49.1%) in Japan. The existence of permanent facilities for nuclear disaster medicine was significantly higher in facilities with fewer years of designation than in those with more years of designation. The existence of permanent facilities for nuclear disaster medicine facilitated the organisational awareness of a nuclear disaster, as evidenced by the availability of manuals, regardless of the number of years elapsed since designation. In conclusion, the study suggests that the existence of permanent facilities is an important factor for organisational preparedness for a nuclear disaster.

Keywords: Manual / Medical staff / Nuclear disaster medicine / Permanent facility / Questionnaire

Résumé – Objectifs: Pour garantir la qualité des soins médicaux en cas de catastrophe nucléaire, des installations sont mises en place dans le monde entier en cas de catastrophe nucléaire. Cependant, la relation entre l'existence d'installations permanentes et la présence ou l'absence de manuels d'utilisation des installations n'a pas été clarifiée dans le domaine de la médecine des catastrophes nucléaires. Cette étude vise à déterminer les relations entre l'existence d'installations permanentes, la présence ou l'absence de manuels d'exploitation et le nombre d'années écoulées depuis qu'une installation a été désignée pour la médecine des catastrophes nucléaires. En septembre 2021, 26 établissements ont répondu à un questionnaire en ligne sur les 53 établissements des hôpitaux liés aux catastrophes nucléaires (taux de réponse valide de 49.1 %) au Japon. L'existence d'installations permanentes pour la médecine des catastrophes nucléaires était significativement plus élevée dans les établissements ayant moins d'années de désignation que dans ceux ayant plus d'années de désignation. L'existence d'installations permanentes pour la médecine des catastrophes nucléaires a facilité la prise de conscience organisationnelle d'une catastrophe nucléaire, comme le montre la disponibilité des manuels, quel que soit le nombre d'années écoulées depuis la désignation. En conclusion, l'étude suggère que l'existence d'installations permanentes est un facteur important pour la préparation organisationnelle à une catastrophe nucléaire.

Mots clés : Manuel / Personnel médical / Médecine des catastrophes nucléaires / Installation permanente / Questionnaire

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1 Introduction

A nuclear disaster is a rare phenomenon worldwide. However, once a nuclear disaster occurs, the scale of damage is significant. To mitigate on- and off-site human suffering in a nuclear disaster, human resource development in nuclear disaster medicine is practised around the world (Cho *et al.*, 2018; Bowen *et al.*, 2020; Shubayr and Alashban, 2022). In Japan, more than 12 yr have passed since the Fukushima Daiichi nuclear power station accident during which the Nuclear Regulation Authority led human resource development training for nuclear disaster medicine (Tsujiguchi *et al.*, 2019). Nuclear disaster medicine has encompassed not only human resource development but also the establishment of facilities in specific nations that provide nuclear disaster medicine (Cho *et al.*, 2018; Marzaleh *et al.*, 2020; Munasinghe *et al.*, 2022). In Japan, facilities have been designated nuclear emergency core hospitals (NECHs) or advanced radiation emergency medical support centres (AREMSCs) since 2015 (Nagata *et al.*, 2022). These facilities are intended to provide appropriate medical care to injured and sick patients, including individuals who are contaminated by or exposed to radiation, in the event of a nuclear disaster (Japan Nuclear Regulation Authority, 2022). To be designated such facilities, it is was necessary to develop 'soft' aspects– such as medical functions and specialised staffing – and 'hard' aspects– such as facilities, equipment, medical materials and equipment and radiation-measuring equipment (Supplementary Tab. 1; Japan Nuclear Regulation Authority, 2022).

The development of software and hardware attributes is important for ensuring that medical facilities can attend to several types of patients during general disasters (Marzaleh *et al.*, 2020; Munasinghe *et al.*, 2022). With regard to hardware, special spaces such as initial treatment and decontamination rooms, in particular, must be developed by medical institutions to receive patients who are injured by radioactive materials (Marzaleh et al., 2020; Munasinghe *et al.*, 2022). Simply installing such hardware has been insufficient. In the past, medical staff were required to prepare manuals that described policies, protocols and procedures to support the use of their facilities' 'hard' aspects (Kutsch, 1956; Shapiro, 1957). The preparation of such manuals is associated with an organisational awareness to utilise the health facility system (Sulzbach and Stivale, 1990). Manuals on facility utilisation are essential (Marzaleh *et al.*, 2020; Munasinghe *et al.*, 2022) and can help medical staff effectively use their facilities (Sulzbach and Stivale, 1990). Therefore, the development of manuals with key information—usage of the facilities, preparation to receive contaminated patients and provide medical care, and establishment of staff roles in nuclear disaster medicine—is associated with the implementation of effective nuclear disaster medicine. As shown in Supplementary Table 1, regardless of the availability of manuals on the use of their facilities, designation as a NECH or an AREMSC is possible if institutions have facilities such as an initial treatment or decontamination room, even if these spaces for receiving contaminated injured patients are temporary. Although more than seven years have elapsed since the designation of facilities for nuclear disaster medicine in Japan, the relationship between the existence of permanent facilities (defined as facilities possessing the relevant hardware in this study) and the presence or absence of manuals for operating the facilities has not been clarified.

Against this backdrop, this study clarifies the relationships between the existence of permanent facilities (*i.e.*, with the relevant hardware), the presence or absence of manuals related to a nuclear disaster, and the years that have elapsed since the designation of the facilities for nuclear emergency medicine. The results of this study can improve medical staff's awareness of nuclear disaster preparedness specific to the usage of facilities and can also contribute to standardising the level of medical care provided to contaminated injured patients.

2 Materials and methods

2.1 Questionnaire survey process

This cross-sectional study was approved by the ethics committee of Fukushima Medical University (approval number: 2019-417) and used a questionnaire for facilities. The questionnaire survey was targeted at 53 NECHs and AREMSCs (hereafter collectively named nuclear disaster-related hospitals; NDRHs) in Japan. Conducted between 1 September and 30 September 2021, the study's questionnaire survey process was as follows: 1) questionnaire survey guidelines and questionnaire items were sent by post to the departments of each facility; 2) department officers in each facility accessed the URL in the guidelines using their PCs and entered responses to the questionnaire items online; and 3) online responses to the questionnaire items were collected.

2.2 Questionnaire items and analytical methods

The questionnaire survey was based on the characteristics of the target medical facilities and was limited to some of the designation requirements for NDRHs (Supplementary Tab. 1). This primary survey focused on three elements: 1) the years that had elapsed since designation as an NDRH; 2) the availability of manuals on nuclear disasters; and 3) the existence of a permanent hardware facility in the NDRH.

The questionnaire queried the following five characteristics of the responding facilities: 1) the annual number of medical personnel that attended nuclear disaster medicine training seminars as of September 2021 per facility (less than 50 or over 50; this number was estimated using the number of seminars per year and the number of NDRHs); 2) the regional classification of NDRHs in Japan (East *versus* West Japan; the classification was according to the region in which the four Nuclear Emergency Medical Support Centres are located (Nagata *et al.*, 2022); 3) the average number of external patients per day at a target facility (less than 1,100 or over 1,100; the number was derived from the average daily number of external patients in a hospital's facilities in Japan in 2019); 4) the years elapsed since designation as an NDRH (less than four years or over four years; the threshold was set to four years given that the average number of years since designation was 3.90 yr as of September 2021); and 5) the availability of manuals on nuclear disasters at the target facility (Yes or No; Yes indicated that the target facility possessed a manual on nuclear disasters). In this context, the availability of nuclear

Table 1. The characteristics of facilities that responded to the questionnaire and the existence of permanent facilities.

		N	Years elapsed since designation as an NDRH			Manuals on nuclear disasters		
			Less than 4 years (*N* =9)	Over 4 years (*N* = 17)	*p* value	No (*N* =8)	Yes (*N* = 18)	*p* value
Characteristics of facilities responding to our questionnaire								
Annual number of medical personnel that attended nuclear disaster medicine training seminar	Less than 50	14	8 (88.9)	6 (35.3)	0.015	5 (62.5)	9 (50.0)	0.683
	Over 50	12	1 (11.1)	11 (64.7)		3 (37.5)	9 (50.0)	
Regional classification of NDRHs in Japan	East Japan area	12	5 (55.6)	7 (41.2)	0.683	3 (37.5)	9 (50.0)	0.683
	West Japan area	14	4 (44.4)	10 (58.8)		5 (62.5)	9 (50.0)	
Average number of external patients per day in an NDRH	Less than 1,100	13	4 (44.4)	9 (52.9)	1.000	5 (62.5)	8 (44.4)	0.673
	Over 1,100	13	5 (55.6)	8 (47.1)		3 (37.5)	10 (55.6)	
Manuals on nuclear disasters	No	8	2 (22.2)	6 (35.3)	0.667	–	–	–
	Yes	18	7 (77.8)	11 (64.7)		–	–	
Years elapsed since designation as an NDRH	Less than 4 years	9	–	–	–	2 (25.0)	7 (38.9)	0.667
	Over 4 years	17	–	–		6 (75.0)	11 (61.1)	
The existence of permanent facilities								
	No	13	2 (22.2)	11 (64.7)	0.048 (Significant by	6 (75.0)	7 (38.9)	
	Yes	13	7 (77.8)	6 (35.3)	one-tailed test)	2 (25.0)	11 (61.1)	0.202
Dedicated emergency room for contaminated patients					0.097 (No significant difference in two-tailed tests)			
Dedicated indoor space for the examination of body surface contamination	No	11	1 (11.1)	10 (58.8)	0.036	6 (75.0)	5 (27.8)	0.038
	Yes	15	8 (88.9)	7 (41.2)		2 (25.0)	13 (72.2)	
Storage facilities for radioactive waste	No	12	1 (11.1)	11 (64.7)	0.016	6 (75.0)	6 (33.3)	0.090
	Yes	14	8 (88.9)	6 (35.3)		2 (25.0)	12 (66.7)	
Water storage tank for storing radioactively contaminated water	No	11	3 (33.3)	8 (47.1)	0.683	6 (75.0)	5 (27.8)	0.038
	Yes	15	6 (66.7)	9 (52.9)		2 (25.0)	13 (72.2)	

NDRH: Nuclear Disaster Related Hospitals.
The table shows the number (percentage) of facilities in each column.

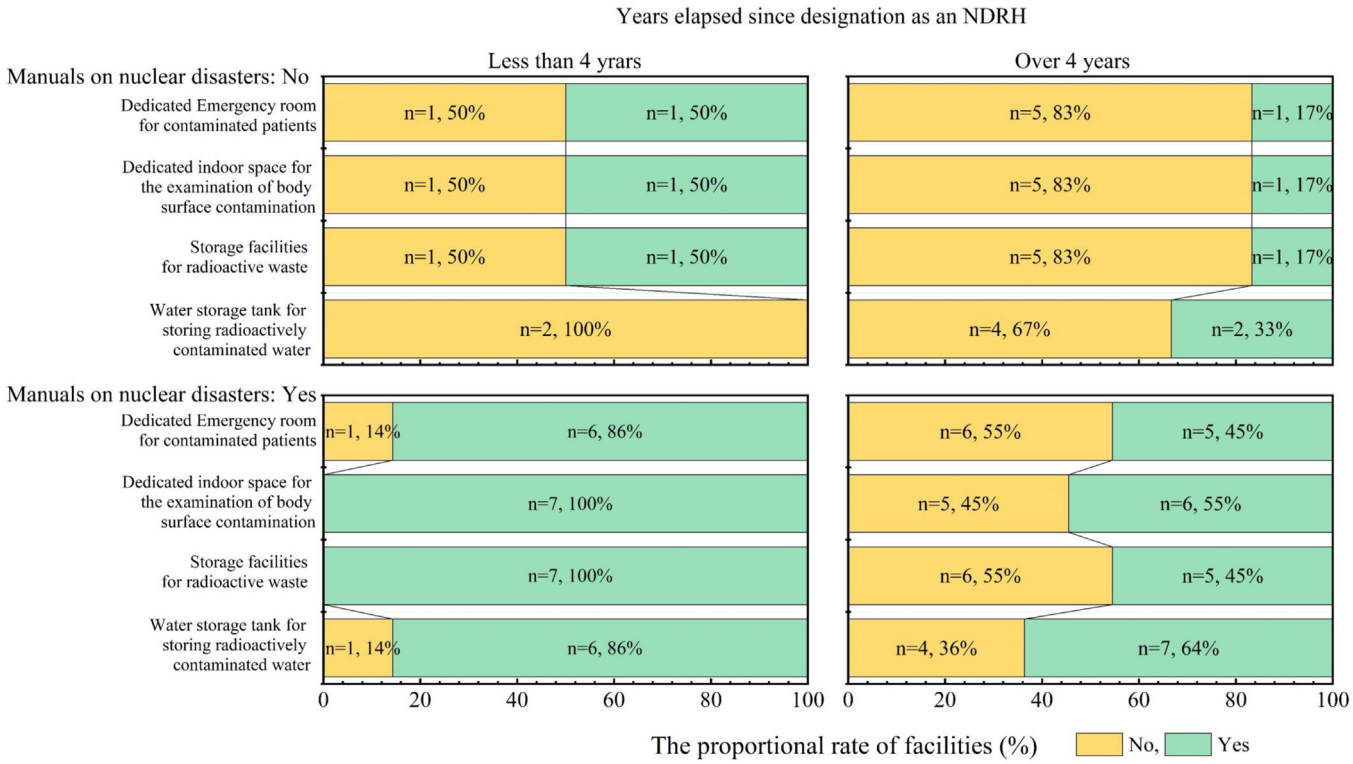

Fig. 1. The number of years elapsed since designation as an NDRH and the availability of manuals on nuclear disasters among each facility. NDRH: Nuclear Disaster Related Hospitals.

disaster manuals refers to the availability of manuals that explain how to use facilities, how to prepare to provide medical care to contaminated individuals, and what roles staff members have in nuclear disaster medicine.

Four items in the questionnaire (see Supplementary Tab. 1) addressed the availability of permanent facilities: 1) a dedicated emergency room for contaminated patients (‘Yes’ or ‘No’; ‘Yes’ if a room was permanently dedicated to receiving contaminated injured patients in a nuclear disaster and ‘No’ if such a room was only temporarily available); 2)a dedicated indoor space for the examination of body surface contamination (‘Yes’ or ‘No’; ‘Yes’ if a facility existed that could prevent the spread of radioactive materials that contributed to body surface contamination and ‘No’ if such a facility was unavailable); 3) storage facilities for radioactive waste (‘Yes’ or ‘ No’ ; ‘ Yes’ if a facility permanently existed that could store waste containing radioactive material contamination and ‘ No’ if such a facility was only temporarily available); and 4) a water storage tank for storing radioactively contaminated water (‘Yes’ or ‘No’; ‘Yes’ if a facility permanently existed for a water storage tank and ‘No’ if such a facility was only temporarily available).

Twenty-six facilities responded to the study questionnaire. The valid response rate for the study was 49.1%. The following methods were used to analyse the responses to the questionnaire items: 1) analysis of the existence of permanent hardware facilities in NDRHs with the number of years elapsed since designation as an NDRH and the availability of manuals on nuclear disaster; 2) comparison across the four items of the trends in the existence of permanent hardware facilities in a 2 × 2 matrix about relationship between the years elapsed since designation as an NDRH and the availability of manuals on nuclear disaster. The analyses were 2 × 2 two-tailed Fisher’s exact tests using the statistical analysis software JMP14.3 (JMP Statistical Discovery LLC, Cary, NC, USA). The significance level for the statistical analyses was set at 5%.

3 Results

Table 1 shows that facilities that had been designated as an NDRH for over four years were significantly more likely to have over 50 total staff ($p = 0.015$) who had attended nuclear disaster medicine training. Moreover, permanent hardware facilities that had been designated as an NDRH for over four years had significantly fewer dedicated emergency rooms for contaminated patients ($p = 0.048$ using the one-tailed test), dedicated indoor spaces for body surface contamination examination ($p = 0.036$) and storage facilities for radioactive waste ($p = 0.016$) than facilities that had been designated as an NDRH for less than four years. Conversely, the availability of manuals on nuclear disasters was significantly more likely when two items specific to permanent facilities (dedicated indoor space for body surface contamination examination [$p = 0.038$] and storage facilities for radioactively contaminated water [$p = 0.038$]) than if these items were temporarily available (Tab. 1). No association was observed between the years elapsed since designation as an NDRH and the availability of manuals on nuclear disasters.

Figure 1 shows the matrix of the years that had elapsed since designation as an NDRH and the availability of manuals on nuclear disasters for the four items specific to the existence

of permanent facilities. We performed a 2 × 2 Fisher's exact test using these data and observed no significant differences in all cases. In the group of facilities which had been designated as an NDRH for over four years and did not have manuals on nuclear disaster, the proportion of non-permanent facilities ranged from 67% to 83% (Fig. 1; right and top). Facilities of 36–55% that had been designated as an NDRH for over four years and in which manuals on nuclear disasters were available were permanent (Fig. 1; right and bottom). The results indicated that the lack of progress in the development of manuals occurred in temporary facilities, despite the long time that had elapsed since their designation as an NDRH. In contrast, 86% to 100% of facilities which had been designated as an NDRH for less than four years and had manuals on nuclear disasters were permanent (Fig. 1; left and bottom). This group was characterised by the fact that the facilities were permanent and the manuals were well developed, despite the short time since designation as an NDRH. The small sample size in the group with less than four years since designation and no manuals on nuclear disasters (Fig. 1; left and top) was attributable to the short time since designation and indicated the urgent need for manual development.

4 Discussion

Enhancing medical facilities to ensure the treatment of radionuclide-contaminated patients in a nuclear disaster is important. The study examined the requirements for establishing permanent medical facilities for a nuclear disaster. The results presented in Figure 1 supported an unexpected relationship between the years elapsed since designation as an NDRH and the existence of a permanent facility. Specifically, the study showed that the development of facilities for nuclear disaster medicine was driven by a strong sense of mission and social factors and was not influenced by the passage of time.

The study indicated that the availability of manuals related to nuclear disasters was associated with the existence of permanent facilities regardless of the passage of time. Table 1 shows a twisting trend between the number of years elapsed since designation as an NDRH and the existence of permanent facilities. Two explanations were provided for the results related to the existence of permanent facilities (Tab. 1). First, facilities for which four years had elapsed since designation as an NDRH may have had a medical staff with a strong sense of mission to provide nuclear disaster medicine without financial support at the time of facility designation. These facilities may have been designated to fulfil minimal requirements (see Supplementary Tab. 1). Second, we presumed that the existence of facilities with less than four years since designation as an NDRH was designated with the financial support of the Cabinet Office of the Japanese government and other authorities for hardware development. Particularly after 2020, the overlapping impact of coronavirus disease 2019 infections with the enhancement of permanent facilities for nuclear disaster medicine highlighted the important role of healthcare facility hardware in a worldwide all-hazards approach to natural disasters and terrorism using chemical or biological attacks (Marzaleh *et al.*, 2020; Munasinghe *et al.*, 2022). This complex combination of disaster factors is considered to have reflected the designation of facilities as NDRHs in Japan. Therefore, this study indicates a case in which the development of medical facilities was driven by social factors.

The permanent establishment of nuclear disaster medical facilities may have further influenced attitudes towards nuclear disaster preparedness, including ensuring the availability of manuals at such facilities. The results in Table 1 and Figure 1 illustrate the relationships between the permanent establishment of nuclear disaster medical facilities, the availability of manuals on nuclear disasters and the years that had elapsed since designation as an NDRH. We hypothesised that facilities for which more years had elapsed since designation as an NDRH were more likely to possess manuals on nuclear disaster.

However, this relationship was shown to be confounded and was dependent on four items specific to the existence of a permanent facility. This result was expected because when items specific to the existence of permanent facilities are present, medical staff at the relevant facility have no choice but to prepare manuals to utilise the relevant hardware, even when the elapsed time since designation as an NDRH is short. Manuals allow healthcare facilities to compile procedures and policies that guide specific actions and disseminate the information to medical staff (Kutsch, 1956; Shapiro, 1957; Sulzbach and Stivale, 1990). Therefore, permanent facilities for nuclear disaster medicine must ensure the development of a manual that guides the entire medical staff in the use of the facilities and increases the facility's nuclear disaster preparedness. Conversely, manuals are not developed when facilities are temporary, even if a long time has elapsed since the designation of the facilities as NDRHs. We presume that this finding is attributable to the difficulty among medical staff in developing manuals for temporary facilities. Therefore, we assert that the establishment of permanent medical facilities for nuclear disaster medicine is important for ensuring the availability of manuals and that such permanent facilities improve the medical staff's awareness of and preparedness for a nuclear disaster.

Finally, the nuclear disaster manuals prepared by facilities should be improved by incorporating multiple perspectives, as described below. For example, the availability of a manual does not guarantee that medical staff will be able to utilise the manual when necessary. To ensure effective utilisation of the manual, medical staff should receive regular radiation-focused education and nuclear disaster training (Cho *et al.*, 2018; Shubayr and Alashban, 2022). Therefore, in addition to facility improvement efforts, personnel training and commitment to manage nuclear disasters should be consistent among all facilities nationwide (Bourguignon, 2022). Furthermore, nuclear disaster manuals must be flexible. Indeed, although domestic NDRHs are intended to accommodate exposed and contaminated individuals during a nuclear disaster, they will also realistically provide medical care for radiation workers or victims of nuclear terrorism with high levels of external and internal exposure (Munasinghe *et al.*, 2022). Therefore, NDRHs should improve their manuals to manage multiple types of radiation emergencies.

5 Study limitations

The study had some limitations. First, the study did not include an investigation of 'soft' aspects, such as the preparation of medical equipment and logistics flows — features that are considered important from a global perspective (Marzaleh *et al.*, 2020; Munasinghe *et al.*, 2022). However, as shown in Supplementary Tab. 1, the NDRHs functioned as core hospitals for general disasters, and the flow of medical materials, equipment and logistics ensured preparedness (Japan Nuclear Regulation Authority, 2022). Additionally, the availability of materials and equipment related to nuclear disaster medicine was included as a requirement for designation (Supplementary Tab. 1); therefore, we considered that the NDRHs already had materials and equipment related to nuclear disaster medicine (Japan Nuclear Regulation Authority, 2022). Second, the study used a questionnaire survey which queried the existence of permanent facilities; therefore, the sample size of responses was small compared with that for a typical questionnaire survey of individuals. As a result, we were unable to perform advanced statistical analyses, such as logistic regression analysis. However, sample sizes in previous studies that included surveys of targeted facilities were similar to that in our study (Munasinghe *et al.*, 2022). Furthermore, given this pilot study's aim of examining the availability of manuals on nuclear disasters, the existence of permanent facilities and the years that elapsed since designation as an NDRH, the study results are sufficiently novel even without the use of advanced statistical analysis methods. Finally, the development of nuclear emergency core hospitals is still ongoing in Japan. Therefore, based on the results of this study, we plan to conduct a full-scale survey of the awareness of nuclear disaster preparedness in each facility in 2024 or beyond. The expected results will contribute to standardising the level of medical care that is provided to contaminated injured patients across Japan.

6 Conclusions

Regardless of the number of years elapsed since designation as an NDRH, the existence of a permanent facility was relevant to the availability of manuals on nuclear disasters in medical establishments. We speculate that when a facility that provides nuclear disaster medicine is permanently present, the awareness of nuclear disaster preparedness increases at the facility, and the medical staff may be more motivated and engaged in the preparation of manuals that guide the utilisation of the hardware. Therefore, medical facilities that prepare for nuclear disaster must not only strengthen 'soft' aspects such as medical staff training but also ensure that the facilities are permanent. Strengthening both software and hardware aspects will make clear the level of national standard for medical care that should be provided to radioactively contaminated injured patients.

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Conflicts of Interest

The authors declare no conflict of interest related to this article.

Author contribution statement

A. Hasegawa and T. Ohba: conceptualisation, methodology; K. Iyama, A. Hasegawa, and T. Ohba: investigation, data curation; T. Ohba: writing original draft, visualisation; A. Hasegawa, K. Iyama, H. Yasuda, and H. Sato: writing-review and editing; A. Hasegawa: funding acquisition. All of the authors have read and agreed to the published version of the manuscript.

Ethics approval

This study protocol was approved by the Fukushima Medical University Ethics Committee (approval number: 2019-417).

Informed consent

Once we received the responses to the questionnaire items from the target facilities *via* the Internet, we were permitted to use the responses in this study.

Supplementary material

Supplementary Table 1. List of designation requirements for nuclear emergency core hospitals and advanced radiation emergency medical support centres in Japan.

The Supplementary Material is available at https://www.radiopro-journal.org/10.1051/radiopro/2023034/olm

References

Bourguignon M. 2022. La nécessaire évolution de la préparation et de la gestion post-accidentelle nucléaire / the necessary development of post-nuclear accident management preparedness. *Radioprotec-tion* 57: 7–8. https://doi.org/10.1051/radiopro/2022003

Bowen A, Veenema TG, Schneider-Firestone S, Iddins C, Boyce D, Davis J, Thornton CP. 2020. Exploring national nursing readiness for a radiological or nuclear incident: a cross-sectional study. *JEmerg Nurs* 46: 600–610. https://doi.org/10.1016/j.jen.2020.06.002

Cho M, Seong KM, Park CY, Bae GR, Kim S, Jin YW. 2018. Sustainable medical preparedness and response system for radiation emergencies in the republic of korea. *Radiat Prot Dosimetry* 182: 20–24. https://doi.org/10.1093/rpd/ncy134

Japan Nuclear Regulation Authority. 2022. *Roles and designation requirements for nuclear emergency core hospitals*, etc. (Japaneses) [online]. Available at: https://www.nra.go.jp/data/000119566.pdf. Accessed 20th July 2023.

Kutsch HJ. 1956. Policy and procedure manual: a guide for consistent action. *Hospitals* 30: 42–44.

Marzaleh MA, Rezaee R, Rezaianzadeh A, Rakhshan M, Haddadi G, Peyravi M. 2020. Design and validation of a hospital emergency department preparedness questionnaire for radiation accidents, nuclear accidents, and nuclear terrorism in iran. *Am J Disaster Med* 15: 283–292. https://doi.org/10.5055/ajdm.2020.0377

Munasinghe NL, O'Reilly G, Cameron P. 2022. Establishing the domains of a hospital disaster preparedness evaluation tool: a systematic review. *Prehosp Disaster Med* 37: 674–686. https://doi.org/10.1017/S1049023X22001212

Nagata T, Arishima T, Yamaguchi Y, Hirohashi N, Usa T, Hasegawa A, Hanada H, Yamamoto N, Okamoto T, Akahoshi T, Hamada M, Abe T, Kikukawa M, Nakao H, Yamamura H, Sakamoto T, Akashi M, Hagihara A. 2022. Radiation emergency medical preparedness in japan: a survey of nuclear emergency core hospitals. *Disaster Med Public Health Prep* 17: e78. https://doi.org/10.1017/dmp.2021.348

Shapiro HL. 1957. How to develop and use program policy and procedure manuals: a program director's guide. *Am J Public Health Nations Health* 47: 975–982. https://doi.org/10.2105/ajph.47.8.975

Shubayr NA, Alashban YI. 2022. Knowledge on radiation emergency preparedness among nuclear medicine technologists. *Radioprotection* 57: 27–31. https://doi.org/10.1051/radiopro/2021024

Sulzbach LM, Stivale DA. 1990. Policy and procedure manual: keeping a high quality manual. *Intensive Care Nursing* 6: 200–204. https://doi.org/10.1016/0266-612X(90)90023-Z

Tsujiguchi T, Ito K, Sato D, Mikami J, Shiroma Y, Hasegawa A, Yamamura H, Kashiwakura I. 2019. The development of an active learning program for the medical responders in a nuclear disaster. *Disaster Med Public Health Prep* 13: 853–858. https://doi.org/10.1017/dmp.2018.168

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