Chapter 9
Psychosocial Challenges of the Fukushima Nuclear Plant Workers

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Abstract The Great East Japan Earthquake and the Fukushima Daiichi nuclear disaster posed major psychological challenges to the nuclear plant workers. The workers had experienced multiple and complex traumatic exposures or "stressors," including a series of workplace chaos (e.g., plant explosion, nuclear meltdown, and radiation exposure), local victim and grief experiences, and extensive societal criticism owing to public criticism toward the electric company. Studies have shown experience of such discrimination and stigma to be a key element to the workers' mental health. As time passed by, these experiences have led to a wide range of mental/behavioral consequences, along with increase in number of retirees and personnel shortages. In the case of Fukushima, the mental health support system was not originally developed as a top-down program, and it took months to launch an official project. In order to provide prompt and comprehensive support in future events, pre-disaster planning and education will be important in designing health-care delivery and surveillance programs. The decommissioning process is

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J. Shigemura, R.K. Chhem (eds.), *Mental Health and Social Issues Following a Nuclear Accident*, DOI 10.1007/978-4-431-55699-2_9

expected to take decades, and it is important that the workers maintain their physical and mental health. A long-term health support system will be a key element to achieve this goal. Collaborations with the media may be helpful in order to improve their mental health by reducing stigma and enhancing social recognition and respect of the workers.

Keywords Disaster mental health • Occupational mental health • Stigma • Discrimination • Public health

9.1 Condition of Workers During the Accident and Its Immediate Aftermath

On March 11, 2011, at 2:46 pm local time, the Great East Japan Earthquake shook the islands of Japan. After the mega-earthquake, waves of tsunamis eventually followed, subsequently leading to a series of accidents at the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi Nuclear Power Plant (henceforth referred to as "Daiichi") accident. Daiichi was severely damaged by the tsunamis reaching as high as 14–15 m [1]. Electric power was completely lost, the reactors became uncontrollable, and hydrogen explosions followed at four of the six reactors. Accidents at reactor nos. 1, 2, and 3 escalated to nuclear meltdown, release of radioactive materials into the environment, mandatory evacuation of the surrounding region, and radiation health concerns among the affected people. TEPCO Fukushima Daini Nuclear Power Plant (henceforth referred to as "Daini"), which was located 12 km south of Daiichi, was also damaged by the earthquake and the tsunamis as high as 7 m. Their power supply remained intact, and thus nuclear meltdown due to decay heat was avoided.

Approximately 11,000 workers, including about 1850 TEPCO full-time employees, had been working for the Daiichi and Daini plants at the time of the disaster. About 90 % of the workers were residents of Fukushima [2]. These workers, along with external support personnel, literally risked their lives to respond to this horrific disaster. Fortunately, no one reported acute radiation health effects from the accident; however, two young Daiichi TEPCO workers and a Daini contractor died from the tsunami waves. Ms. Tomoko Yamamoto, a Daini nurse, confessed in her interview as follows:

> When the first explosion occurred on March 12, we had to respond to numbers of casualties. . . . They had high radiation exposure. . . . They had to take off their clothes until their radiation level had decreased. Some of them had high radiation level on their hair even though they had wiped them. So they had to use hats or towels to cover their heads, and for some, we cut their hair. We were out of water so we could not wash them.
>
> The Daiichi employees had worked without rest or sleep, with only water and biscuits. Some of them blacked out on their way (from Daiichi) to the treatment room. One worker did not sleep for two days and lost consciousness with his protective mask on. We had to give intravenous fluids to five exhausted workers at the same time. [3]

Table 9.1 Complex stressors of Fukushima nuclear plant workers

Work-related experience
Earthquakes and tsunamis
Plant explosions
Radiation exposure
Extreme overwork
Victim experience
Mandatory evacuation
Property loss
Family dispersion
Grief experience
Colleagues
Families
Friends
Social backlash
Public criticism
Discrimination
Harassments
Guilt as "perpetrators"

Dr. Tanigawa (coauthor) has been a part-time occupational physician of the Daiichi and Daini since 1991. It was not until April 16, 2011, however, when he was approved to make his first site visit since the accident occurred. Upon this visit, he directly encountered the immense and complex stressors that these workers had been facing. The stressors fell into four main categories (Table 9.1). Firstly, their experience of trauma at the workplace was overwhelming. Many of them were dealing with earthquakes, tsunamis, plant explosions, and possible radiation exposure. A substantial number of these workers said they literally thought they were going to die; in a newspaper interview, Dr. Tanigawa reported, "the workers are in the front line of a battlefield" [4]. The late Mr. Masao Yoshida, the Daiichi director during the disaster, later reflected, "I was thinking about faces of people who will die with me" [5]. Secondly, as the vast majority of the workers were local people, their personal lives had also been substantially affected by the disaster through property losses or evacuation. Thirdly, the workers had to overcome their own grief experiences resulting from the disaster, in particular, the loss of their loved ones, their families, and their colleagues. Lastly, the workers were facing severe discrimination and bashing from the public. As reported in the *Tokyo Shimbun*, "when a worker took their day off and went to evacuation shelters to see his family, evacuees had their finger and said "*Tohden*" (TEPCO) and made slanderous statements to him" [6].

After the disaster, the Daiichi workers had to spend their time off within the Daiichi building or in the Daini gymnasium. Some workers had to respond to the continuous recovery efforts; some employees had no time to return to their home between shifts; other workers had lost their homes and were unable to find a new place to live. They were working continuously, slept on floors or chairs, and were

unable to use showers and had to share their linens. The workers had limited variety of food and had been eating canned/vacuum-packed foods for over a month.

Since the disaster, I had imagined the struggles of the workers and had hoped that someone, probably from the government or the electric company, must have been providing ample mental health care to the hardworking heroes. This was not the case, however, and the mental health support system had yet to be implemented. In order to provide mental health support to these workers, Dr. Tanigawa and I agreed to collaborate; on May 6, 2011, I became the first mental health professional to enter the Fukushima plant after the disaster [7].

Upon speaking with the workers, we learnt about their stressors. A significant majority of them said, "I thought I was going to die" and showed a wide variety of posttraumatic stress responses including intrusive flashbacks, avoidance of their plant, hypervigilance toward aftershocks, fear of irradiation, and dissociative episodes. Grief was a major issue in their workplace along with their personal lives. The workers were severely discriminated against and harassed by the local residents. One man said that his neighbors saw him in TEPCO uniform and verbally abused him. Another worker reported that a real estate company refused to rent his family a house; another employee added that his neighbor insulted him for parking his car near the neighbor's home.

With knowledge of these experiences, we conducted a study 2–3 months after the disaster examining the mental health status of 1495 full-time TEPCO workers (Daiichi, $n = 885$; Daini, $n = 610$). The data showed the workers had experienced essentially these four stressors. About half ($n = 470$, 53.1 %) of the Daiichi and a quarter ($n = 153$, 25.1 %) of the Daini workers had life-threatening experiences; about two-thirds of the whole group ($n = 999$, 66.8 %) had their homes evacuated. Two to three out of ten workers (Daiichi, $n = 378$, 25.3 %; Daini, $n = 117$, 19.2 %) had high posttraumatic stress responses (PTSR; ≥ 25 on the Japanese version of the Impact of Event Scale-Revised [8]). In multivariate analysis, those with discrimination/slur experiences, compared with those without, were two to three times more likely to have high PTSR (Daiichi: adjusted odds ratio, 2.17; 95 % confidence interval, 1.43–3.30, $p < 0.001$; vs. Daini: adjusted odds ratio, 2.70; 95 % confidence interval, 1.47–4.96, $p = 0.001$) [9].

An in-depth study [10] examined the pathway from nuclear disaster exposures, distress during and immediately after the event (peritraumatic distress; PD), to posttraumatic stress to PTSR. For both Daiichi and Daini groups, PTSR was highly associated with PD (Daiichi: adjusted β, 0.66; $p < 0.001$; vs. Daini: adjusted β, 0.67; $p < 0.001$). While most disaster-related variables were likely to be associated with PD (and not with PTSR), discrimination/slur experience was associated with both PD and PTSR (Daiichi: adjusted β, 0.11; $p < 0.001$; vs. Daini, adjusted β, 0.09; $p = 0.005$).

9.2 Condition of Workers During the Recovery Phase

The nuclear plant decommissioning process is expected to take decades, and the workers face increasing challenges to stabilize the situation. However, ongoing cleanup problems, such as leaks of irradiated water, put the workers in a tough position. Adverse public responses to the nuclear plant workers include, but is not limited to, scapegoating, discrimination, and stigmatization; "the public turned hostile toward the nuclear industry and TEPCO, or "Tohden" in Japanese, became a dirty word [11]." This social dynamic has led to self-stigmatization for these workers, and they try to mask their social identity to the public to avoid stigma [12]. The workers typically say, "I don't want my neighbors to see my TEPCO uniform," "in community activities, I can't say who I work for," or "I can't write my profession when I have to turn in documents."

As time went by, the workers' distress evolved into chronic stressors and a variety of consequences. Some suffered from psychiatric disorders (e.g., depression, posttraumatic stress disorder, adjustment disorder), while others have had maladaptive behavioral changes, such as increased alcohol or tobacco use. A large majority of the workers had to struggle with decreased work motivation, resulting in increased errors and accidents. The number of injured workers has been on the rise. In fiscal year (FY) 2014, the number of Daiichi workers who suffered injuries was 64, double of that in FY 2013. Among them, 15 suffered heat stroke, 13 had injuries from falling, and another 13 had their bodies caught in the machinery [13]. In January 2015, a series of fatal accidents occurred at Daiichi and Daini [14].

Furthermore, a significant proportion of workers have chosen to quit their jobs. In FY 2012, over 700 TEPCO employees retired. This number was nearly 1.5 times higher than that of FY 2011 (465 workers) [15]. About 40 % of them were in supervisory positions, and TEPCO offered a temporary bonus (100,000 Japanese yen or approximately 833 US dollars) to supervisors in order to stop this trend [16].

Radiation exposure is also a substantial issue among these nuclear plant workers. The Japanese law designates the accumulative radiation dose limit of radiation workers as either 50 millisievert (mSv) per year or 100 mSv per 5 years; a dose threshold for emergency work is 100 mSv. Immediately after the Fukushima accident, the government temporarily raised this threshold to 250 mSv among emergency workers. Radiation exposure is not only related to their health consequences but also their working environments. If the workers' radiation dose exceeds the limit, they are mandated to leave frontline work and instead work off-site. However, this measure results in not only exacerbation of personnel shortages but also adjustment issues to the workers' new jobs and contractor layoffs.

In the first year after the disaster, the workers' accumulated radiation exposure was prominent, especially among TEPCO workers (vs. contractors). Among 21,125 workers (3416 TEPCO employees and 17,709 contractors), 174 workers (150 TEPCO employees and 24 contractors) exceeded a dose of $\geq$100 mSv with

Table 9.2 Accumulated radiation exposure dose distribution among Fukushima Daiichi nuclear plant workers (March 2011–December 2014, adapted from [17])

	March 2011–March 2011 ($N = 21{,}125$)				April 2012–March 2013 ($N = 13{,}741$)			
	TEPCO ($n = 3416$)		Contractors ($n = 17{,}709$)		TEPCO ($n = 1625$)		Contractors ($n = 12{,}116$)	
Radiation dose (mSv)	*n*	%	*n*	%	*n*	%	*n*	%
Above 250	6	0.2	0	0	0	0	0	0
200–250	1	0	2	0	0	0	0	0
150–200	26	0.8	2	0	0	0	0	0
100–150	117	3.4	20	0.1	0	0	0	0
75–100	186	5.4	65	0.4	0	0	0	0
50–75	257	7.5	258	1.5	1	0.1	0	0
20–50	630	18.4	2660	15.0	62	3.8	675	5.6
10–20	491	14.4	2892	16.3	129	7.9	2000	16.5
5–10	376	11.0	2557	14.4	266	16.4	1875	15.5
1–5	589	17.2	4621	26.1	579	35.6	3326	27.5
1 or less	737	21.6	4632	26.2	588	36.2	4240	35.0
Maximum dose (mSv)	678.8		238.4		54.1		43.3	
Average dose (mSv)	25.1		10.1		4.4		5.9	
	April 2013–March 2014 ($N = 14{,}746$)				April 2014–December 2014 ($N = 18{,}187$)			
	TEPCO ($n = 1692$)		Contractors ($n = 13{,}054$)		TEPCO ($n = 1623$)		Contractors ($n = 16{,}564$)	
Radiation dose (mSv)	*n*	%	*n*	%	*n*	%	*n*	%
Above 250	0	0	0	0	0	0	0	0
200–250	0	0	0	0	0	0	0	0
150–200	0	0	0	0	0	0	0	0
100–150	0	0	0	0	0	0	0	0
75–100	0	0	0	0	0	0	0	0
50–75	0	0	0	0	0	0	0	0
20–50	31	1.8	629	4.8	5	0.3	604	3.7
10–20	95	5.6	2067	15.8	17	1.1	1651	10.0
5–10	195	11.5	1897	14.5	130	8.0	2340	14.1
1–5	670	39.6	3739	28.6	573	35.3	5015	30.3
1 or less	701	41.4	4722	36.2	898	55.3	6954	42.0
Maximum dose (mSv)	41.9		41.4		24.2		39.9	
Average dose (mSv)	3.2		5.5		1.7		4.3	

Abbreviations: *TEPCO* Tokyo Electric Power Company, *mSv* millisievert

a maximum of 678.8 mSv. From FY 2012, the radiation dose has been controlled so that it will not exceed 50 mSv, but this control makes it harder for the employer to select already limited on-site workers (Table 9.2) [17].

9.3 Reflections About Radiation Workers' Mental Health

9.3.1 Health Service System for the Nuclear Plant Workers

Many lessons can be learned from the Fukushima disaster on worker health support systems during nuclear plant emergencies. The establishment of a mental health service system for nuclear plant workers was a challenging bottom-up process. Before the disaster, mental health services to Daiichi and Daini plant workers were provided by a part-time psychiatrist from Minamisoma, a city located 30 km north of Daiichi. After the disaster, however, the main road between Minamisoma and Daiichi was blocked, hampering the efforts of this doctor to enter the restricted area. After Dr. Tanigawa made his first on-site visit after the disaster in mid-April 2011, he spoke about the lack of mental health professionals to treat nuclear plant workers and the urgent needs of worker care in the media.

Since the disaster, I had imagined the struggles of the workers and had hoped that someone, probably from the government or the electric company, must have been providing ample mental health care to the hardworking heroes. I was surprised, however, that it was not the case and that Dr. Tanigawa had to speak through the media to launch a support project. I immediately called him; we agreed to collaborate and, on May 6, 2011, Dr. Tanigawa and I visited the Fukushima plant. In a twist of fate, I happened to be the first mental health specialist to enter the plant after the disaster and had to create a novel mental health support system [7].

After my first visit, Dr. Tanigawa and I began to negotiate with a variety of people such as the governors, officials, and TEPCO Headquarters' representatives. I work for the National Defense Medical College, a medical school for the Japanese Ministry of Defense. My college bosses (Soichiro Nomura and Yoshino Aihide) urged the college and the ministry officials to establish an official mental health support team. After a series of repeated discussions, the Prime Minister's Cabinet ordered the Ministry of Defense to form a mental health support team for nuclear plant workers on June 24, 2011 (i.e., over 3 months after the disaster). We eventually entitled this project as the Fukushima NEWS Project (NEWS, Nuclear Energy Workers' Support) and have since continued to provide support to TEPCO Daiichi and Daini workers.

A similar bottom-up process was also observed in health-care services inside the nuclear plant. Immediately after the disaster, TEPCO full-time occupational physician (Dr. Akira Tsuyuki) and nurses (Ms. Tomoko Yamamoto among others) were the only on-site medical staff to respond to the Daiichi and Daini workers. The Daiichi treatment room was disabled owing to tsunamis, so a temporary medical treatment room was immediately set up at Daini to respond to workers of Daiichi and Daini. They literally worked endlessly to respond to Daiichi explosions and subsequent chaos, and external medical support was not provided for nearly a month. When Ms. Yamamoto was asked what her most distressing experience was, she said, "We didn't have staff to take turns with us. I was in the plant on a

24-hours-a-day basis for 20 days in a row, but we did not have rotating staff or external support teams, so we had to find them on our own" [3].

These experiences show that the Fukushima workers' mental health service was first formed as a bottom-up process and evolved into a top-down system. The service started from a mere private phone call between two physicians, and the team professionals were not selected by a registration list, if any. This experience highlights a potential of providing ample, comprehensive, and prompt mental health (or any other health) services immediately after the disaster by a top-down process. Development of a highly trained health-care response team system might be helpful in order to realize this. Such a service will also be critical to prevent burnout of local health-care providers, who are also likely to be disaster victims.

9.3.2 The Roles of Mental Health Professionals in Support of Nuclear Plant Workers

The workers' well-being was severely challenged by the Great East Japan Earthquake and the Daiichi accident. Multiple social roles were added to the workers, including workplace trauma victim, local survivor, the bereaved, and a target of social backlash.

This phenomenon made it a challenge for mental health professionals to provide interventions. Traditional clinical roles of psychiatrists or psychologists (e.g., patient vs. doctor setting) were not enough in planning mental health-care programs to this population. The professionals had to implement the fundamentals of disaster mental health and had to create strategies for the primary, secondary, and tertiary tiers of care [18]. These strategies required multidisciplinary efforts; related fields included, but are not limited to, public health, radiology, occupational health, sociology, history, anthropology, and politics. In general, mental health professionals are not trained to take on this sophisticated task. Likewise, non-mental health workers are not trained to tackle the complex dynamics between their discipline and mental health.

In order to prepare for future events, it will be of importance to emphasize comprehensive and multidisciplinary efforts in professional education courses as well as development and implementation processes [19]. In the case of Fukushima, worker surveillance programs will be important to understand their long-term consequences, to establish effective interventions [20], and to ascertain the associations between multiple disciplines [19].

9.3.3 Public Criticism and the Role of Media

In public health crises, mass media play a large role in sending out public messages. This point is especially emphasized in "imperceptible" disaster responses, such as CBRNE (chemical, biological, nuclear, radiological, and explosive agents) attacks, toxic exposures, and pandemics [18, 21]. Media can potentially send out information related to safety, health, and behavioral decisions. On the other hand, media reports can get sensational (so-called media hypes) and stigmatize the affected people and/or organizations [22]. Although it is beyond the scope of this chapter, discrimination and stigmatization issue is an ongoing matter for all the people affected by this disaster [23].

Clear, accurate, and consistent information exchange is an essential component between health-care workers, leaders, governments, media, and the general public [18] in order to disseminate adaptive knowledge to the crisis. Not all health-care professionals, let alone mental health professionals, are trained to perform these risk communication roles, such as collaborating with the media, sending public health messages, and promoting public decision-making processes.

Given this principle, we hypothesized that collaboration with the media might be helpful to increase the respect and to decrease the stigmatization of the nuclear plant workers. The disseminated information included their research data [9, 10] as well as the "voices" of the workers. Among the media headlines were "Life as a Fukushima cleanup worker – radiation, exhaustion, public criticism" [24] and "Why Japan's 'Fukushima 50' remain unknown [25]." In fact, two nonfiction novels [5, 26] reported the workers' horrific life-threatening experiences, work ethics, and struggles under their own names. Although anecdotal, such information might be helpful for the public to better understand what the workers had been through.

9.4 Conclusion and Messages

The workers at the Fukushima Daiichi and Daini nuclear power plants risked their lives in order to stop the plants that were damaged by the tsunami. The destruction of Daiichi resulted in nuclear meltdown and radiation release, although the situation could have been worse if the workers had not attempted to confront it. However, the psychosocial price to these heroic efforts was profound. A large majority of the workers were also local victims of this disaster and had to cope with bereavement issues. Furthermore, owing to post-disaster societal dynamics, the extent of societal criticism was excessively higher than appreciation for their sacrifices.

In the case of Fukushima, a mental health support system for the workers was developed in a bottom-up fashion. In order to provide prompt and comprehensive support in future events, top-down leadership as well as multidisciplinary efforts

will be crucial. Pre-disaster planning and education may be essential to formulate health-care delivery and surveillance systems.

Decommissioning efforts will continue for decades to come. It is important for the nuclear plant workers to maintain their physical and mental well-being as well as the dignity they deserve. Collaborations with the media may be helpful for the public to learn the inner struggles of the workers and to understand the importance of support and respect to them.

Conflict of Interest and Disclaimers JS, SN, and AY provided mental health assistance to TEPCO Fukushima Daiichi and Daini nuclear power plant workers according to official requests from Daini and a Japanese government cabinet order to the Ministry of Defense.

This work was partly supported by Health and Labour Sciences Research Grants (Research on Occupational Safety and Health H24-001) from the Ministry of Health Labour and Welfare of Japan and Senshin Medical Research Foundation grant.

The views expressed in this article are those of the authors and do not reflect the position or policy of TEPCO, National Defense Medical College, the Ministry of Defense, the Japanese government, and any other institutions.

Acknowledgments Our hearts go out to the victims and the affected people of the Fukushima disaster. Our condolences especially go to Mr. Kazuhiko Kokubo and Mr. Yoshiki Terashima, the Daiichi TEPCO workers who lost their lives by the tsunami attacks, and Mr. Masao Yoshida, Daiichi director during the disaster, who passed away in 2013.

We are grateful to the workers of the Fukushima Daiichi and Daini nuclear power plants for their bravery and efforts. We thank the collaborators of the Fukushima NEWS Project (in alphabetical order): Drs. Chiyo Fujii, Tatsuro Kuwahara, Shin-ya Sano, Yutaka Sato, Shoichi Tachibana, Sho Takahashi, Yoshitomo Takahashi, Yasutaka Tatsuzawa, and Hiroyuki Toda.

We are indebted to Ms. Tomoko Yamamoto, R.N. (TEPCO Fukushima Daini Nuclear Power Plant), Ms. Mariko Tanaka, R.N. (TEPCO Fukushima Daiichi Nuclear Power Plant), Ms. Yoshiko Kage (TEPCO R&D Center), Dr. Hiroshi Kikuchi (TEPCO Head Office), as well as the medical team staff of Daiichi, Daini, and the TEPCO Head Office for their cooperation and support. Supports from the Division of Human Health, Department of Nuclear Sciences and Applications, International Atomic Energy Agency, is gratefully acknowledged.

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