


ORIGINAL ARTICLE

Effects of the Great East Japan Earthquake and the Fukushima Daiichi Nuclear Power Plant accident on behavioural and psychological symptoms of dementia among patients

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Abstract

Background: The Great East Japan Earthquake triggered accidents at the Fukushima Daiichi Nuclear Power Plant, becoming the first complex disaster that included both a natural and a nuclear power disaster. This study examines how complex disasters affect patients with dementia.

Methods: Participants included the 331 people diagnosed with dementia out of the 2482 new patients (between January 2008 and December 2015) at a psychiatric hospital located in the indoor sheltering zones nearby mandatory evacuation zones. Medical records were retrospectively examined to identify the number of new patients with dementia, the severity, their chief complaints, and the behavioural and psychological symptoms of dementia (BPSD) types. BPSD were classified into the hyperactive BPSD group and the hypoactive BPSD group. The hyperactive BPSD group was further subdivided into the hyperactivity-impulsivity-irritability-disinhibition-aggression-agitation group, which exhibited agitation, disinhibition, and irritability, and the psychosis group, which exhibited delusions and hallucinations. The hypoactive BPSD group included depression, inactivity, apathy, and anxiety. Results were divided into the period before the complex disaster (2008–2010) and after (2012–2015) and were compared. In addition, the post-complex-disaster period was subdivided into the early phase (2012–2013) and the late phase (2014–2015).

Results: The proportion of new patients with dementia increased significantly after the disaster. Although there was no change in patients' age and the disease's severity, the proportion of patients whose chief complaint was BPSD increased significantly after the disaster. Furthermore, there was a significant increase in the hyperactivity-impulsivity-irritability-disinhibition-aggression-agitation group in the early post-complex-disaster phase and a significant increase in the psychosis group in the late post-complex-disaster phase.

Conclusion: This complex disaster caused increased consultations from patients with dementia and increased BPSD. Additionally, it increased participants' symptoms of agitation and irritability in the early post-complex-disaster phase and the proportion of hallucinations and delusions in the late post-complex-disaster phase.

INTRODUCTION

Following the earthquake and tsunami from the Great East Japan Earthquake (GEJE, 2011), an explosion occurred at the Fukushima Daiichi Nuclear Power Plant (FDNPP), making this the first complex disaster in history which included natural and nuclear power disasters. To avoid radiation exposure, residents within a 20 km radius of the FDNPP received mandatory evacuation orders, and those within a 20–30 km radius were ordered to shelter indoors (Fig. 1).

Exposure to serious disasters causes post-traumatic stress disorder and other mental illnesses,¹ and exposure to radioactive contamination, in particular, has a lasting effect on residents' mental health.² A study of the general population of Ichinoseki City, approximately 168 km from the FDNPP, found that the psychological distress of those who experienced both the earthquake and radioactive contamination may have been greater than those who lived through a single disaster.³

Several studies^{4–7} have found that disasters like earthquakes and complex disasters comprising earthquakes and tsunamis have a negative effect on the conditions of patients with dementia; however, no prior studies have explored the effects of complex disasters involving radioactive contamination on patients with dementia. Thus, we investigated the

number of consultations of patients with dementia and types of behavioural and psychological symptoms of dementia (BPSD) at a psychiatric hospital near the FDNPP before and after the complex disaster involving radioactive contamination.

METHODS

Participants

The researchers reviewed the records of 2482 patients who visited the Department of Psychiatry at Hibarigaoka Hospital (Fig. 1) for the first time between January 2008 and December 2015. Hibarigaoka Hospital is located 25 km from the FDNPP, and it provided medical services before and after the complex disaster. Of these 2482 patients, the medical records of 331 patients whose primary diagnosis was dementia were included in the study and retrospectively examined. Since there were only a small number of new patients in 2011, the year the complex disaster occurred, that year was eliminated from the study.

Groups and comparisons

The participants were divided into the group before the complex disaster (January 2008–December 2010)

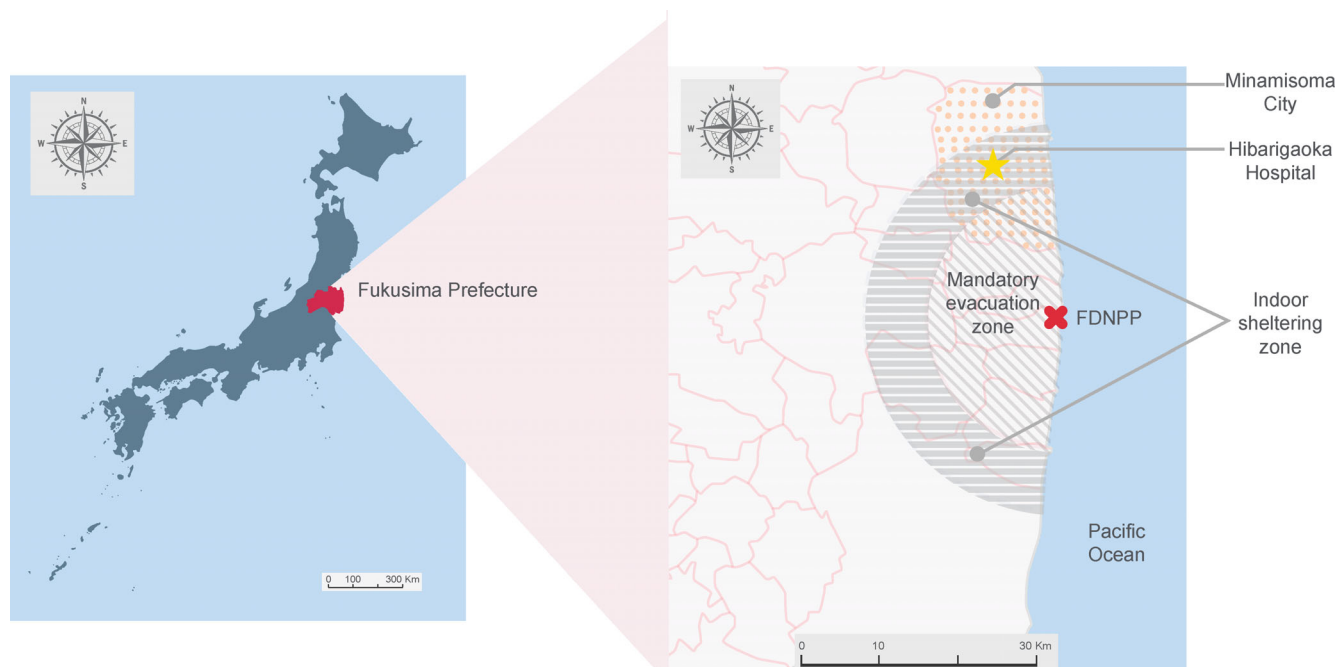


Figure 1 The positional relationship between Hibarigaoka Hospital and Fukushima Daiichi Nuclear Power Plant.

and the group after the complex disaster (January 2012–December 2015). The tenth edition of the International Classification of Diseases⁸ was used to diagnose dementia, and diagnoses were classified as Alzheimer's disease, vascular dementia, or other dementia types. We investigated the total number of new patients, the number of new patients diagnosed with dementia, their age, gender, chief complaints, type of dementia, severity of illness using the Functional Assessment Staging (FAST),⁹ and living situation for each group before and after the complex disaster. Next, we divided the chief complaints into two types: core dementia symptoms (such as amnesia and executive dysfunction) and BPSD. We evaluated the presence or absence of BPSD described in the medical records with reference to the items of the Neuropsychiatric Inventory.¹⁰

For patients who displayed both core dementia symptoms and BPSD, the type of symptom that distressed their caregiver the most was defined as the chief complaint. Using prior clustering analysis research^{11–13} of BPSD as a guide, we subdivided the BPSD types that were the most difficult for caregivers into the hyperactive BPSD group, including agitation, irritability, hallucinations, and delusions, and the hypoactive BPSD group, including depression, inactivity, apathy, and anxiety.

In addition, the hyperactive BPSD group was subdivided into the hyperactivity-impulsivity-irritability-disinhibition-aggression-agitation (HIDA) group, which exhibited mainly agitation, disinhibition, and irritability, and the psychosis group, which exhibited mainly delusions and hallucinations. The symptom that distressed their caregiver the most and required treatment was defined as the main symptom. We then compared these symptoms before and after the complex disaster. We also divided the period after the complex disaster into the early post-complex-disaster phase (2012–2013) and late post-complex-disaster phase (2014–2015) and similarly compared them.

Statistical analyses

We used an independent *t*-test to examine the differences in the ages of the participants and the severity of their illness according to the FAST, before and after the complex disaster. For categorical variables including gender, living situation, diagnosis, chief complaints, and each BPSD type, a Chi-square test or Fisher's exact test was conducted. A *P*-value of less than 0.05 was regarded as statistically significant. The

tests were conducted using the SPSS software (version 25; IBM, Armonk, New York, USA).

Ethics

This study was approved by the ethics committee of the Fukushima Medical University (no. 29078).

RESULTS

The proportions of patients diagnosed with dementia to all new patients before and after the complex disaster were 96 out of 1078 (8.9%) and 235 out of 1404 (16.7%), respectively; thus, the proportion of patients with dementia increased significantly after the complex disaster ($P < 0.001$). Additionally, compared to the early post-complex-disaster phase (91 out of 638, 14.3%), the proportion of patients with dementia in the late post-complex-disaster phase (144 out of 766, 18.8%) increased significantly ($P = 0.023$).

Table 1 shows the participants' background and chief complaints classification. No significant difference was found concerning gender, age, or living situation of patients with dementia before and after the complex disaster. There was also no significant difference in the type or severity of dementia before and after the complex disaster. The number of patients whose chief complaint was BPSD increased significantly ($P < 0.001$) after the complex disaster (79.6%) compared to before the complex disaster (60.4%).

Regarding BPSD types, most were in the HIDA groups both before and after the complex disaster, and no significant difference was found before and after the complex disaster ($P = 0.093$) (Table 1). However, there was a significant increase in the HIDA group during the early post-complex-disaster phase ($P = 0.013$) (Table 2). Then, in the late post-complex-disaster phase, the levels returned to those seen before the complex disaster. The psychosis group increased significantly after the complex disaster ($P = 0.034$) (Table 1). However, no significant increase was found in the early post-complex-disaster phase ($P = 0.198$) (Table 2), while a significant increase was found in the late post-complex-disaster phase ($P = 0.018$) (Table 3).

Table 4 shows how the content of hallucinations and delusions before the complex disaster and in the late post-complex-disaster phase. Theft delusions were the most frequent in the late post-complex-disaster phase. The numbers of psychiatric symptoms were too small for performing statistical comparisons.

Table 1 Participants' background and results

	Before the complex disaster (2008–2010) N = 96	After the complex disaster (2012–2015) N = 235	P-value
Age, years, mean ± SD	81.8 ± 5.73	82.8 ± 6.80	0.186 [†]
Females, <i>n</i> (%)	67 (69.8)	141 (60)	0.094 [‡]
Functional assessment staging (FAST), mean ± SD	5.07 ± 1.08	5.02 ± 1.14	0.680 [†]
Living situation, <i>n</i> (%)			0.794 [§]
Single	10 (10.4)	31 (13.2)	
With one's spouse or brother or sister	19 (19.8)	44 (18.7)	
With one's spouse and child	58 (60.4)	130 (55.3)	
Nursing home	8 (8.3)	28 (11.9)	
Unknown	1 (1.0)	2 (0.9)	
Dementia diagnosis, <i>n</i> (%)			0.299 [‡]
Alzheimer's disease	79 (82.3)	180 (76.6)	
Vascular dementia	11 (11.5)	27 (11.5)	
Other (DLB, FTD)	6 (6.2)	28 (11.9)	
Chief complaint, <i>n</i> (%)			<i>P</i> < 0.001 [‡]
Core symptoms of dementia	38 (39.6)	48 (20.4)	
BPSD	58 (60.4)	187 (79.6)	
BPSD type, <i>n</i> (%)			
HIDA	45 (46.9)	134 (57.0)	0.093 [‡]
Psychosis	8(8.3)	41 (17.4)	0.034 [‡]
Hypoactive behaviour	5 (5.2)	12 (5.1)	0.580 [§]

[†]Independent *t*-test. [‡]Chi-square test. [§]Fisher's exact test. N: total number of new patients with dementia during each period. The % shows the ratio of the frequency of each factor to the total number of new patients with dementia in each period. BPSD, behavioural and psychological symptoms of dementia; DLB, dementia with Lewy bodies; FTD, frontotemporal dementia; HIDA, hyperactivity-impulsivity-irritability-disinhibition-aggression-agitation. Psychosis: hallucination or delusion. Hypoactivity behaviours: depression, inactivity, apathy, and anxiety.

Table 2 Frequency of BPSD types before the complex disaster and in the early post-complex-disaster phase

	Before the complex disaster (2008–2010) N = 96	The early post- complex- disaster phase (2012–2013) N = 91	P- value
BPSD type, <i>n</i> (%)			
HIDA	45 (46.9)	59 (64.8)	0.013 [†]
Psychosis	8 (8.3)	13 (14.3)	0.198 [†]
Hypoactive behaviour	5 (5.2)	2 (2.2)	0.245 [‡]

[†]Chi-square test. [‡]Fisher's exact test. Abbreviations are the same as in Table 1.

Table 3 Frequency of BPSD types before the complex disaster and in the late post-complex-disaster phase

	Before the complex disaster (2008–2010) N = 96	The late post- complex-disaster phase (2014–2015) N = 144	P-value
BPSD type, <i>n</i> (%)			
HIDA	45(46.9)	75(52.1)	0.429 [†]
Psychosis	8(8.3)	28(19.4)	0.018 [†]
Hypoactive behaviour	5(5.2)	10(6.9)	0.586 [†]

[†]Chi-square test. Abbreviations are the same as in Table 1.

Table 4 The contents of hallucinations and delusions before the complex disaster and in the late post-complex-disaster phase

	Before the complex disaster (2008–2010) N = 96	The late post- complex-disaster phase (2014–2015) N = 144
Hallucination, <i>n</i> (%)		
Visual	3 (3.1)	5 (3.5)
Tactile	1 (1.0)	0
Delusion, <i>n</i> (%)		
Theft	2 (2.0)	14 (9.7)
Jealousy	0	5 (3.5)
Other delusion of persecution	0	4 (2.8)

Other delusions of persecutions: delusion of poverty, intrusion, observation, being killed. Abbreviations are the same as in Table 1.

DISCUSSION

Trends in consultations by patients with dementia before and after the complex disaster

In this study, there was a significant increase in the proportion of patients with dementia among all new patients after the complex disaster. There was a link between the chronic continuation of psychological

stress and dementia onset,⁷ and experiences such as changing residence and losses of homes and other assets were risk factors for dementia exacerbation.^{6,14,15} Residents of the study area, nearly 72 000 people at the time of the disaster, moved on average six times,¹⁶ and 20% moved at least seven times.¹⁷ Therefore, in addition to the damage and suffering caused by the earthquake and tsunami, the repeated need to move to seek refuge from radiation exposure may have increased psychological stress¹⁸ and contributed to the development of dementia or BPSD. In fact, it has been reported that patients with dementia forced to make frequent moves to different evacuation facilities began to show BPSD.¹⁹ Furukawa et al.⁴ have shown that among those who experienced both earthquakes and tsunamis, BPSD was significantly exacerbated among those who evacuated compared to those who did not. According to their report,⁴ there was no significant difference in cognitive function deterioration between the group that evacuated and the group that did not. However, participants in the present study were forced to move more times, which may have exacerbated dementia or BPSD and increased the number of new consultations. The working-age population decreased to 45%–69%,²⁰ and the number of nursing care facilities in operation also decreased;²¹ thus, there were fewer opportunities for older adults to access the nursing care they needed. This possibly was an important factor in the increased number of patients with dementia consultations. The increase in the number of consultations was more conspicuous in the late post-complex-disaster phase than in the early post-complex-disaster phase; this can be attributed to the long-term reduction in access to appropriate care. This may also be related to the disaster's specific features, which include long-term psychological effects from radioactive contamination.²

BPSD frequency before and after the complex disaster

Among patients whose chief complaint was BPSD, both the HIDA and psychosis groups increased significantly after the complex disaster. Factors such as living environment and dementia severity may affect BPSD emergence,²² but in the present study, there was no change in the living situation and dementia severity before and after the complex disaster. This

suggested there are other factors behind the BPSD increase. The mechanism by which disasters directly exacerbate BPSD is unknown, but since factors such as the breakdown in circadian rhythm, changes in the environment, and loss of habitual lifestyle are known to trigger BPSD,²³ living in evacuation shelters may have increased BPSD. Furthermore, participants' caregivers were also impacted by the complex disaster, which may have influenced participants. Caregivers' mental health was not investigated in this study, but since people in Fukushima who experienced the complex disaster faced high levels of ongoing psychological distress,^{17,24} it is possible that caregivers' mental health also declined. And this decline may have led to the deterioration of relationships between caregivers and patients, thus accelerating BPSD appearance.²² Furthermore, the reduced number of nursing care facilities also meant that a larger burden of nursing care was placed on caregivers, further contributing to the negative impact on their mental health, and in turn possibly contributing to increased BPSD among patients.

BPSD characteristics before and after the complex disaster

Comparing the early and late post-complex-disaster phases, we found there was an increase in the HIDA group in the early phase compared to before, but in the late phase, it returned to a similar level as before the complex disaster. In a study by Furukawa et al., soon after the earthquake, people who experienced the entire complex disaster (both the earthquake and the tsunami) showed a significant increase not in hyperactive BPSD but in BPSD such as depression and anxiety, compared to those who had not.⁵ We conducted our investigation by extracting the BPSD types that were most difficult for caregivers. Possibly, the bias caused by the influence of the BPSD type on the degree of caregiving burden²⁵ affected the differences between our findings and those of Furukawa et al. Furthermore, complex disasters involving radioactive contamination may be characterised more by hyperactive BPSD than by BPSD such as depression and anxiety.

Regarding the psychosis group, compared to before the complex disaster, there was no increase in the early post-complex-disaster phase, but there was a significant increase in the late post-complex-

disaster phase. Interestingly, after the complex disaster, a greater diversity of delusions related to other people emerged, including delusions of being watched or intrusion in addition to theft. It is thought that most of the participants in this study experienced evacuation. Hence, factors such as difficulty maintaining privacy at shelters and a lost sense of security may have influenced the emergence of persecution delusions. The long time spent living in evacuation shelters due to radioactive contamination²⁶ and the long time spent in an environment different from one's usual routine may have contributed to the increase in hallucinations and delusions as time went on after the complex disaster. Comparatively speaking, of the various BPSD types, delusions do not normally persist, but it has been shown that agitation does persist.^{27,28} For this study, we did not trace the progress of the same group over time. However, it is possible that the course of BPSD onset was different for patients with dementia forced to spend long periods living in evacuation shelters due to radioactive contamination.

This study had several limitations. First, since this was a retrospective study based on medical records, the investigation items that could be included in analysis were limited. In addition, the sample size was too small for further analysis of each dementia diagnosis. Second, since we focussed on the BPSD that were most difficult for caregivers, hypoactive BPSD may have been underestimated. Despite these limitations, this study contributes valuable knowledge regarding trends seen among patients with dementia in an area that experienced a complex disaster involving radioactive contamination.

In conclusion, the complex disaster of the GEJE and the FDNPP increased the number of consultations by patients with dementia and increased BPSD. Furthermore, in the early post-complex-disaster phase, the proportion of BPSD such as agitation and irritability, increased, while in the late post-complex-disaster phase, the proportion of hallucinations and delusions increased.

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