Original Article

Evaluation of Fatigue in Cancer Patients in An Area Affected by The Great East Japan Earthquake

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ABSTRACT

Objective: The objective of this study is to evaluate fatigue in cancer outpatients receiving chemotherapy using an objective system and to clarify the type of nursing support needed after a disaster. **Methods:** Based on the diagnostic criteria for chronic fatigue syndrome, the degree of subjective fatigue, autonomic function, and amount of physical activity were measured in cancer outpatients undergoing chemotherapy from an area affected by the Great East Japan Earthquake. **Results:** The study participants were ten adults (8 men [80.0%] and 2 women [20.0%]). Significant differences were seen in subjective physical fatigue (P = 0.347), mental fatigue (P = 0.128), comprehensive fatigue (P = 0.621), and comprehensive evaluations (P = 0.293); however, no significant differences were seen in the results for changes over time for any survey item. The balance between sympathetic and parasympathetic nerve function changed statistically significant with time (log low frequency [LF] [P = 0.039] and log LF/high frequency [HF] [P = 0.021]). In all participants, autonomic nervous function was enhanced in the sympathetic nervous system, and the sympathetic nervous system was dominant. Significant differences were observed between the three measurements for mean diurnal activity (P = 0.027), total sleep time (P = 0.011), sleep efficiency (P = 0.019), awakening (P = 0.032), and naps (P = 0.037). **Conclusions:** In the event of a disaster, in addition to self-care support for side effects caused by anticancer drugs, patients' physical and mental conditions are assessed in terms of fatigue using objective indicators, and then, appropriate nursing support is provided. The nurse grasps objective facts behind the patient's subjective data and systematically recommends adjustments to the patient's daily life. In addition, by providing appropriate information to patients, patient education specific to each patient is provided.

Key words: Autonomic nerves, cancer patients, chemotherapy, fatigue, sleep, the Great East Japan Earthquake

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Introduction

Cancer treatment in Japan has shifted from wards to home care as the duration of stay in hospitals has decreased. The Basic Act on Anti-Cancer Measures in Japan aims "to build a society in which cancer patients can live with peace of mind while maintaining dignity and receive not only appropriate medical care but also welfare support, according to the situation. Educational and other types of necessary support can also be received."[1] With improvements in chemotherapy, the number of cancer survivors has been increasing through continued treatment in the outpatient setting.[2] After a disaster, such as the Great East Japan Earthquake of March 2011, the top priority of medical institutions is to provide treatment to patients in need of immediate treatment. Thus, cancer outpatients receiving chemotherapy in the areas affected by the disaster were unable to continue treatment as originally planned. Now that several years have passed since the Great East Japan Earthquake, the development of lifelines, the restoration of public transportation, and the construction of public housing for disasters have progressed, and the situation before the earthquake has been restored. However, cancer patients in the affected areas lost their families and friends due to the tsunami, and their lives changed significantly compared to before the earthquake. With this background, many have concerns about the stress and adverse health effects caused by the prolonged life changes that accompanied the Great East Japan Earthquake.[3-7]

Cancer patients who receive chemotherapy need to control their lives in good balance with the fatigue caused by anticancer drugs, gastrointestinal symptoms, infections associated with bone marrow suppression, and anemic symptoms.[8] Therefore, cancer patients in the disaster-affected areas were affected by stress related to both the disaster and their disease and treatment, meaning that they had to receive treatment with additional physical and mental burdens. Environments subject to excessive tension or stress predominate the sympathetic nervous system, affecting sleep, increasing the risk of fatigue, and leading to decreased immunity and higher risks for infection. In addition, information exchange in the brain is diminished, and in some cases, fatigue is not noticeable, even when an individual is tired. In other words, subjective and objective evaluations of fatigue do not always coincide in cancer patients. Cancer patients living in disaster-affected areas are likely to be unconsciously burdened with physical and mental health. If this condition continues, the risks of a worsening cancer condition, chronic fatigue syndrome, sudden death, overwork death, cardiovascular disease, and mental health disorder may increase. With this background, the aims of the present study were to evaluate fatigue in cancer outpatients receiving chemotherapy using an objective system and to clarify the type of nursing support needed after a disaster.

Methods

Participants

Cancer outpatients undergoing chemotherapy at a clinic in a general hospital in an area affected by the Great East Japan Earthquake were randomly selected as the study participants. The attending physician explained the study objectives and methods to all patients before obtaining informed consent. The target hospitals were those randomly selected in the affected areas that agreed to participate.

Content of evaluations

In this study, patient evaluations were carried out based on personal attributes and the diagnostic criteria for chronic fatigue syndrome.[9-11] Among the auxiliary items highly useful for the diagnosis of chronic fatigue syndrome, the evaluation of autonomic nerve function and physical activity (sleeping time and arousal average activity evaluation) was selected. For personal attributes, age, gender, type of cancer, cancer medication, marital status, employment status, performance status (PS), cancer stage, housing damage status, and temporary housing status were investigated. Autonomic nervous function was evaluated by measuring the acceleration pulse wave, which has been verified as an objective quantification method for fatigue.

The acceleration pulse wave measurement used a pulse wave meter (Altet 2; U-Medica, Osaka, Japan). The low-frequency (LF) component (0.04–0.15 Hz) is an index of sympathetic nerve function, and the high-frequency (HF) component (0.15–0.40 Hz) is an index of parasympathetic nerve function. Relative sympathetic nerve function was calculated based on the LF/HF ratio, with <2 was good.

A questionnaire survey was conducted to evaluate the participants' subjective feeling of fatigue. The usefulness of the questionnaire has been verified by the Ministry of Health, Labor and Welfare of Japan.[9-11] This questionnaire is composed of ten physical fatigue items (40 points), ten mental fatigue items (40 points), and twenty comprehensive fatigue items (80 points). The physical and mental fatigue items are scored on a scale of none (0) to very strong (4) and evaluated based on the total as follows: physical fatigue for men – 0–7 points (good), 8–11 points (attention), and ≥12 points (careful); physical fatigue for women – 0–8 points (good), 9–13 points (attention), and ≥14 points (careful); mental fatigue for men – 0–9 points (good), 10–12 points (attention), and ≥ 13 points (careful); and for women – 0–10 points (good), 11–15 points (attention), and ≥16 points (careful). Overall fatigue is the sum of the

physical and mental fatigue scores: for men – 0–16 points (good), 17–22 points (attention), and ≥23 points (careful) and for women – 0–19 points (good), 20–28 points (attention), and ≥29 points (careful).

Physical activity was evaluated using a wristwatch-type accelerometer for 72 h on the nondominant hand. This instrument can detect an acceleration change with a threshold of 0.01 G/Rad/s in the range of 2–3 Hz, count the number of times over 0, and record the number of acceleration changes per minute. Sleep was evaluated based on five indicators: mean diurnal activity (DA), naps, total sleep time (TST), awakening (AW), and sleep efficiency (SE).

Data collection

Autonomic nervous function was evaluated between 09:00 and 10:00 before the start of chemotherapy. The subjective assessment of fatigue was assessed using a questionnaire that was subsequently collected through mail. For the physical activity evaluation, the participants were asked to wear the measurement device in the same position as the wristwatch-type accelerometer for 3 days. To minimize the effect of chemotherapy drugs, the measurement date was 7 days after the start of treatment. A total of three measurements were taken every month.

Statistical analysis

The LF, HF, and LF/HF components were quantified by heart rate fluctuation analysis using the acceleration pulse wave meter and then logarithmized. Data from the 1st, 2nd, and 3rd measurements were subjected to the Friedman's test. Fisher's exact test was used for the comparisons of subjective fatigue. DA, naps, TST, AW, and SE were calculated to evaluate physical activity using the analysis software. The level of significance for all tests was set at 5%.

Ethical approval

This study was carried out with cooperation from the hospital director and general manager of the general hospital the participants received treatment and was approved by the Ethics Committee of the cooperating hospital (Approval No. 2012-06).

Results

The study participants were ten adult cancer outpatients (8 men [80.0%] and 2 women [20.0%]). Lung cancer was the most common type of cancer (five patients [50.0%]). Seven patients (70.0%) were receiving anticancer drugs, and two (20.0%) were receiving drugs through intravenous drip and oral administration. As for the effects of the earthquake, the housing condition was complete destruction for two patients (20.0%), partial destruction for two patients (20.0%), no destruction for six patients (60.0%), and temporary housing for five patients (50.0%) [Table 1].

Significant differences were seen in subjective physical fatigue (P = 0.347), mental fatigue (P = 0.128), comprehensive fatigue (P = 0.621), and comprehensive evaluations (P = 0.293); however, no significant differences were seen in the results for changes over time for any survey item [Table 2].

The balance between sympathetic and parasympathetic nerve function changed significantly with time (log LF [P = 0.039] and log LF/HF [P = 0.021]). On the other hand, no significant change in log HF (P = 0.193) was

Table 1: Characteristics of patients (n = 10)

Items	*n* (%)
Average age, Mean ± SD	69.1±14.3
Gender	
Men	8 (80.0)
Women	2 (20.0)
Type of cancer	
Lung	5 (50.0)
Rectum	2 (20.0)
Breast	2 (20.0)
Prostate	1 (10.0)
Administration method of anticancer drug	
Drip	7 (70.0)
Internal use	1 (10.0)
Both	2 (20.0)
Spouse	
Exist	8 (80.0)
Working	
Yes	3 (30.0)
PS	
0	3 (30.0)
1	5 (50.0)
2	2 (20.0)
Damage to houses	
Complete destruction	2 (20.0)
Partial destruction	2 (20.0)
No destruction	6 (60.0)
Temporary housing	
Entering	5 (50.0)

PS: Performance status

Table 2: Subjective fatigue

Items	Mean±SD/*n* (%)			*P*
	First time	Second time	Third time	
Physical fatigue	8.59±3.02	8.96±2.94	9.21±3.67	0.347
Mental fatigue	10.26±3.79	10.07±3.89	9.88±3.51	0.128
Comprehensive fatigue	18.87±6.23	19.21±6.82	18.49±7.09	0.621
Comprehensive evaluation				
Good	5 (50.0)	5 (50.0)	5 (50.0)	0.293
Attention	3 (30.0)	4 (40.0)	3 (30.0)	
Careful	2 (20.0)	1 (10.0)	2 (20.0)	

Friedman's test, Fisher's exact test. SD: Standard deviation

observed. In all participants, autonomic nervous function was enhanced in the sympathetic nervous system, and the sympathetic nervous system was dominant [Table 3].

Significant differences were observed between the three measurements for DA ($P = 0.027$), TST ($P = 0.011$), SE ($P = 0.019$), AW ($P = 0.032$), and naps ($P = 0.037$) [Table 4].

Discussion

The study participants were all cancer patients who were using multiple anticancer drugs in combination and receiving treatment at an outpatient clinic. Their PS classification ranged from 0 to 2, and it is presumed mild symptoms. However, few of the participants were women. Half of the participants had been forced to move into temporary housing because of the effects of the Great East Japan Earthquake, and the lives and living environments of several of the participants had changed significantly compared with before the earthquake.

Significant changes were seen in subjective fatigue over time. These causes are thought to be due to changes to the environment in which treatment would be concentrated and self-care ability for side effects. Seventy percent of the participants were in an environment where they could focus on treatment without having to work; their PS was good, and they could carry out activities of daily living independently. Therefore, the participants were considered to have adopted coping behaviors for the effects of the disaster. Although the participants were aware of the symptoms of fatigue caused by the anticancer drugs, it is surmised that by repeating their experiences as cancer survivors, they were able to readjust well. On the other hand, it is possible that the patients targeted in the disaster-affected areas were unaware of their fatigue symptoms, as they had recently undergone drastic changes in their living environment and thus had no time to feel tired. When thinking about coping behaviors, such as taking a rest and engaging in hobbies, fatigue must be recognized subjectively by each individual.

In the evaluations of autonomic nervous function and physical activity, significant differences were observed in changes over time. These changes are considered to be the effects of stress from the Great East Japan Earthquake. Stress affects the balance of the sympathetic and parasympathetic nervous system.[12,13] Compared with healthy individuals, the participants in the present study had a log LF/HF, and their sympathetic nervous system was relatively dominant. In this study, surveys were conducted 1.5 years after the earthquake. The recovery period to overcome an acute disaster is a time when recovery is progressing, which differs from the confusion period immediately after a disaster, when individuals are engaged in activities such as debris removal and moving to temporary housing. However, temporary housing may affect autonomic nervous function by causing stress associated with limited living spaces and thin walls. Experiencing stress from both the earthquake and cancer treatment is considered to have a greater effect on the autonomic nervous system than experiencing cancer treatment alone.

As the LF and HF components decrease with age, the power value also decreases because of the reduced thickening of the arterial wall and the increased pressure due to vasoconstriction.[14,15] In particular, the HF component, which reflects parasympathetic nerve function, is reported to decrease rapidly with age and to exacerbate fatigue.[5] Most of the participants in the present study were elderly people aged ≥65 years, but the measured values were at a high level compared with the log HF (standard value: 1.50) of healthy individuals. The plasma concentrations of noradrenaline and adrenaline have a 24-h circadian rhythm, with adrenaline at a minimum around 03:00 before increasing sharply to a peak around 09:00. As a generalized response to physical and mental stress, the sympathetic nervous system is activated, and the parasympathetic nerves are suppressed.[11,16,17] In the present study, the autonomic nervous function of the participants was evaluated immediately before the start of chemotherapy after an outpatient examination. The measurement time was from 10:00 to 12:00. Therefore, in view of the physiological response of the participants' plasma concentrations and psychological state just before the anticancer drug treatment, it is possible that the increase in the LF value could be predicted and that the LF/HF ratio would be out of balance. To maintain homeostasis, not only the autonomic nervous system but also regulatory

Table 3: Evaluation of autonomic nervous function

Items	Mean			*P*
	First time	Second time	Third time	
Log LF	2.46	2.65	2.34	0.039
Log HF	2.19	2.1	2.22	0.193
Log LF/HF	0.27	0.38	0.16	0.021

Friedman's test. LF: Low frequency, HF: High frequency

Table 4: Physical activity evaluation

Items	Mean±SD			*P*
	First time	Second time	Third time	
DA	1.6±0.8	1.7±0.9	1.4±0.9	0.027
TST (Min	440.3±55.6	466.9±62.7	418.3±53.3	0.011
SE (%)	92.8±5.3	91.8±6.8	94.1±2.2	0.019
Aw (Times)	8.3±2.8	10.8±3.7	6.2±3.3	0.032
Naps (Times)	5.3±3.1	9.4±3.2	4.1±2.6	0.037

Friedman's test. DA: Diurnal activity, TST: Total sleep time, SE: Sleep efficiency, AW: Awakening, SD: Standard deviation

functions such as the endocrine and immune systems need to be in a state of allostasis.[18] Nurses check cancer patients' vital signs for evidence of any adverse effects of anticancer drugs. In addition, nurses pose intentional questions to such patients to gain a better understanding of their perception of changes in their living environment. It is important to create an environment where care professionals listen to cancer patients' complaints about their anxieties and pain and cooperate with other specialists to support them. It is also important to prevent the deterioration of cardiovascular disease, overwork death, and sudden death while paying attention to physical and mental changes other than those caused by cancer treatment.

The results of the physical activity evaluations showed that the patients' sleep cycles changed in accordance with changes in autonomic nervous function. The first measured sleep time was about 440 min. If focusing only on this sleeping time, it is considered that there is no problem, even if it is judged that the sleeping condition is good. However, sleeping efficiency was very poor (SE = 92.8%), and more than eight halfway AWs were recorded. It is surmised that the participants spent time sleeping and napping during the day when they should be active, leading to an overall increase in sleeping time. It is said that stress before sleep onset affects autonomic nervous function during sleep.[19,20] In general, fatigue is experienced by everyone on a daily basis and is relieved in a short time by rest and sleeping at night. However, fatigue among cancer patients has been reported to cause persistent exhaustion because of disease progression and the side effects of anticancer drugs, and sometimes cannot be treated, which cause additional frustration. In the present study, autonomic nerve function was measured before the administration of anticancer drugs, and physical activity was evaluated 1 week after receiving anticancer drugs. However, because there are large individual differences in the timing and extent of side effects, it is possible that fatigue may have affected sleep. The results of the autonomic nervous function evaluations correlated with the results regarding the sleeping state. These findings suggest the necessity of considering the timing and frequency of measurements of objective indicators in the case of treatments that exert excessive stress on the body, such as chemotherapy.

Direction of nursing

The simple measuring instrument used in this study objectively quantifies subjective fatigue and can be applied to care according to each individual. Autonomic nervous function is very sensitive to chemotherapy, and sleep disorders are prevalent. The aim of care professionals is to grasp the objective facts behind a patient's subjective data and systematically adjust their overall daily life. In addition, by providing appropriate information to patients, care professionals practice patient education unique to each person. After the Great East Japan Earthquake, patients who required emergency treatment were prioritized, which delayed treatment for cancer outpatients. Planned treatments could not be implemented at the time of the disaster for all participants of the present study, and two patients had to postpone. Cancer patients can often deal with large-scale disasters; however, they are often affected by not only disaster-related stress but also mental and physical disorders such as anxiety about disease progression due to the inability to continue treatment regularly. Such conditions affect autonomic nervous function and the sleeping state, which can lead to chronic fatigue. In the event of a disaster, patients are assessed not only for self-care support for side effects caused by anticancer drugs but also for fatigue based on physical and mental conditions using objective indicators, and nursing support is tailored to each situation. In addition, when treatment cannot be continued because of disaster-related damage, support to allow patients' wishes is to be identified and referrals to a medical area or a hospital outside of affected areas, even in the same prefecture, is necessary.

Conclusion

In the event of a disaster, in addition to the provision of support for self-care in regard to the side effects caused by anticancer drugs, patients need to be assessed for physical and mental fatigue using objective indicators, and nursing support needs to be provided.

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Conflicts of interest

There are no conflicts of interest.

References

1. Ministry of Health, Labor and Welfare in Japan. Overview of the Basic Plan to Promote Cancer Control Programs. Available from: http://www.mhlw.go.jp/stf/seisakunitsuite/bunya0000183313.html/. [Last accessed on 2018 Apr 08].
2. Hirao C, Mikoshiba N, Shibuta T, Yamahana R, Kawakami A, Tateishi R, *et al*. Adherence to oral chemotherapy medications among gastroenterological cancer patients visiting an outpatient clinic. Jpn J Clin Oncol 2017;47:786-94.
3. Shinichiro A. The great east Japan earthquake and mental health of Iwate prefecture staff. Iwate J Public Health 2013;24:6-12.
4. Mikiko H. Characteristics of stressful eventsand stress levels among affected health care workers in the early stages of disasters. J Jpn Society Disaster Nurs 2013;15:66-82.
5. Takashi W, Toshinori S, Toru T, Yasutake E, Yumi S, Msateru K, *et al*. Changes in subjective symptom rate before

and after the great East Japan earthquake. Ann Health Lab Welfare Rep 2013;60:1-6.
6. Yilmaz V. A statistical analysis of the effects on survivors of the 1999 earthquake in Turkey. Soc Behav Personal 2004;32:551-8.
7. Atsushi S, Masaaki T, Toshitaka R. Survey of mental health support activities for disaster relief teams and residual members in the Great East Japan Earthquake. Ann Res Rep JSDF Sapporo Gen Hosp 2013;51:47-51.
8. Hopkinson J. Psychosocial support in cancer cachexia syndrome: The evidence for supported self-management of eating problems during radiotherapy or chemotherapy treatment. Asia Pac J Oncol Nurs 2018;5:358-68.
9. Mizuno K, Tanaka M, Yamaguti K, Kajimoto O, Kuratsune H, Watanabe Y. Mental fatigue caused by prolonged cognitive load associated with sympathetic hyperactivity. Behav Brain Funct 2011;7:17.
10. Mizuno K, Tajima K, Watanabe Y, Kuratsune H. Fatigue correlates with the decrease in parasympathetic sinus modulation induced by a cognitive challenge. Behav Brain Funct 2014;10:25.
11. Kuratsune H. Establishment of objective fatigue diagnosis method and creation of chronic fatigue diagnosis guidelines for patients complaining of chronic fatigue with autonomic dysfunction. Health Lab Sci Res Grant Res Rep 2012. Available from: https://www.fuksi-kagk-u.ac.jp/guide/efforts/research/kuratsune/h23/pdf/h23houkoku.pdf. [Last accessed on 2018 Apr 08].
12. Vaillancourt M, Chia P, Sarji S, Nguyen J, Hoftman N, Ruffenach G, *et al.* Autonomic nervous system involvement in pulmonary arterial hypertension. Respir Res 2017;18:201.
13. Abboud FM, Singh MV. Autonomic regulation of the immune system in cardiovascular diseases. Adv Physiol Educ 2017;41:578-93.
14. Yamaki F, Obara K, Tanaka Y. Angiotensin II regulates excitability and contractile functions of myocardium and smooth muscles through autonomic nervous transmission. Yakugaku Zasshi 2019;139:793-805.
15. Tobaldini E, Toschi-Dias E, Appratto de Souza L, Rabello Casali K, Vicenzi M, Sandrone G, *et al.* Cardiac and peripheral autonomic responses to orthostatic stress during transcutaneous vagus nerve stimulation in healthy subjects. J Clin Med 2019;8. pii: E496.
16. Wang X, Liu B, Xie L, Yu X, Li M, Zhang J, *et al.* Cerebral and neural regulation of cardiovascular activity during mental stress. Biomed Eng Online 2016;15:160.
17. Langewitz W, Rüddel H, Schächinger H, Lepper W, Mulder LJ, Veldman JH. Changes in sympathetic and parasympathetic cardiac activation during mental load: An assessment by spectral analysis of heart rate variability. Homeost Health Dis 1991;33:23-33.
18. Ramsay DS, Woods SC. Clarifying the roles of homeostasis and allostasis in physiological regulation. Psychol Rev 2014;121:225-47.
19. Cole RJ, Kripke DF, Gruen W, Mullaney DJ, Gillin JC. Automatic sleep/wake identification from wrist activity. Sleep 1992;15:461-9.
20. Hall M, Vasko R, Buysse D, Ombao H, Chen Q, Cashmere JD, *et al.* Acute stress affects heart rate variability during sleep. Psychosom Med 2004;66:56-62.