Research Article

The Effect of Intentional Communication, Recreation, and Rehabilitation on the Autonomic Nervous Activity of Elderly Persons with Dementia: A Case Study

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Abstract

Background

Little is known about the relationship between daytime activities and autonomic nervous activities of elderly persons. Individual interventions for elderly persons have been considered to reduce daytime somnolence. Oftentimes, daytime somnolence interferes with daytime activities which are critical to maintaining human health and well-being.

Purpose

The aim of this case study was to determine the association between rehabilitation, recreation, intentional communication activities, and autonomic nervous activity in the elderly person with dementia.

Method

A 90 year-old woman nursing home resident in Shikoku Island, Japan, who had serious dementia (Hasegawa Dementia Scale-Revised score was 10) was the subject of the case study. Autonomic nervous activity data was recorded using Holter electrocardiogram (ECG). The researcher observed and recorded the participant’s daily life activities. Rehabilitation, recreation, and intentional communication were instituted according to a prescribed procedure. The following data was discovered: LF (Low Frequency)/HF (High Frequency) ratio, HF power and spectral gradient $\beta$ (1/f fluctuation) were analyzed by the Memcalc/Chiram3.
Results

The 1/f fluctuation during rehabilitation, recreation, and intentional communication were -1.07, -1.48, and -1.54, respectively. The mean LF/HF ratio increased as compared with the baseline, and the mean value of HF power decreased. However, both mean value of LF/HF ratio and HF power increased during the time with thermotherapy as rehabilitation intervention. Intentional communication and nursing home daytime activities were associated with autonomic nervous activity among the elderly person with dementia. Findings using specific procedures suggested that daytime somnolence can be decreased and daytime activities increased.

Keywords: dementia, elderly, autonomic nervous activity, intentional communication, 1/f fluctuation

Introduction

The current global estimate of the number of patients with dementia is 35,600,000. It is predicted that this will increase to 65,700,000 people by 2030, and will increase to 115,400,000 by 2050. The greatest risk factor of dementia is aging. In 2010, the number of patients with dementia was about 2 million. It is predicted that with the rapid increase of the elderly population that patients with dementia will increase in number to 3,250,000 people in 2020 (Shimokata, 2004). Statistical data estimates that 11.3% of Japanese elderly people will have dementia of various types in 2020.

Dementia symptoms can be divided into “core symptoms” such as impaired memory, disorientation, and aphasia and “peripheral symptoms” such as delusions and roaming (Mori, & Ueno, 2011). For sleep disorder, sleep rhythm changes for nocturnal delirium, loitering, and somnolence in the daytime are common problems, as a result, good sleep is inhibited. Mishima (2010), has shown that extensive physiology, such as autonomic nerve system, endocrine system, and cardiovascular system, can coexist in sleep disorders.

Kathy, Cornelia, Patricia, & Valorie, (2005), and Yamanaka, Nakata, Ishizuka, Hirata, Suzuki, & Amano, (2008), reported that individual intervention affects elderly people’s sleep state. However, little is known about influences on sleep by individual patients with dementia. Takeda, Matsuda, and Etou, (2010), and Takeda, and Matsuda, (2013), mentioned that interventions such as reading aloud, and having a pleasant conversation, were performed with healthy elderly persons. Research revealed an observed change of activity of the autonomic nervous system. As for pleasant conversations, as compared with reading aloud, it was shown that during the intervention sympathetic nerve activity was active. Moreover, it was shown that after the intervention, parasympathetic nerve activity became active. In one research study, a dialogue was performed for five minutes for ten elderly persons with dementia (Hasegawa dementia rating scale-revised from 4 to 10 points). Five people had conversation as an intervention in which sympathetic nerve activity increased, while after intervention, sympathetic nerve activity decreased. However, two persons showed that parasympathetic nerve activity increased after intervention (Chiba, Watanabe, Tanioka, Iwasa, Osaka, Yasuhara et al., (2011). It was also reported that there was no significant difference before and during intervention LF (Low Frequency)/HF (High Frequency) ratio and HF power.

These studies (Takeda, et al. 2010, 2013; and Chiba et al., 2011) showed that elderly people’s autonomic nervous activity and sleep conditions have been influenced by individual interventions. However, among cognitively impaired elderly persons...
in institutions, influence on autonomic nervous activity by individual interventions and individual interventions within groups were not found to be significant.

Most people living in nursing homes have daytime somnolence (Mishima, 2010), although in Japan, there is little individual approach. Most group activities (called recreation) have been provided for these patients. However, as for mental activity to express feelings and to maintain high motivation, these were found effective in reducing arousal during sleep time among healthy elderly people (Shirota, Tamaki, & Itono 2001a). Also, Shirota revealed that high-volitional individuals spent more time experiencing mental activities during the daytime than low-volitional individuals. These results suggest that a high-volitional lifestyle may contribute to maintaining good nocturnal sleep in the elderly (Shirota, Tamaki, Nittono, Hayashi, & Hori, (2001b). It is thought that with effective influence on persons with dementia will exist with mental stimulation.

**Purpose**

The aim of this case study was to determine the effect of rehabilitation, recreation, intentional communication activities, and autonomic nervous activity in the elderly person with dementia.

**Method**

**Procedure for Data Collection**

**Case Presentation.**

This study used the case study method. The participant was a 90 year-old woman who lived in a nursing home in Japan. She was diagnosed with Alzheimer-type dementia. The Hasegawa Dementia Rating Scale-Revised was 10 (serious dementia). This score was obtained according to the evaluation conducted on December, 9, 2012. Her cognitive function indicated consistent but decreasing process. Being in a reclining position (loss of active musculo-skeletal movements) becomes extensive because of leg pain. She can move around by herself but only using a wheel chair. She does not relate well to others. She does not take medications that affect her heart functions. Her hobby is calligraphy and playing the Taisho harp.

**Data Collection**

This participant was equipped with a portable Holter ECG monitor for 24 hours. Heart rate variability (HRV) is an efficient non-invasive method to investigate the autonomic nervous function and cardiovascular control during awake or sleep (Baharav, Kotagal, Gibbons, Rubin, Pratt, Karin, & Akselrod, 1995). Electrodes were placed on her chest and recorded by electrocardiograph (ECG) by a Holter ECG machine (Nihonkoden, Tokyo, Japan) for 24 hours. LF component (0.04-0.15 Hz) was extracted by power spectrum density. HF component (0.15-0.50 Hz) was extracted as an indicator of parasympathetic nervous system activity. The LF/HF ratio indicated sympathetic nervous system activity.

Normal resting heart rate was measured before and after intervention. A prescribed procedure included the following: 10:00~10:50 rehabilitation, 14:30~15:20 recreation and 15:50~16:20 intentional communication. Intentional communication was conducted within the following conditions: ambient room temperature of 25 to 28 degrees celsius, degree of humidity of 55 to 65%.

**Interventions**

The contents of the intervention comprised of (1) a Rehabilitation procedure that included performance of this participant at standing position exercise from a seating position 11 times with assistance using parallel bars. Rehabilitation using thermotherapy was performed at the hip, tip of foot, and the left knee.
(2) The recreation procedure was also performed during the quiet time which included calligraphy. (3) Intentional communication was done for thirty minutes using photographs in order to recollect participant’s memories. Examples of these photographs included pictures of a human baby, dogs, cats, and scenery of Japan. The conversation time for each photograph was not limited. The partner in the conversation performed only repetition of the words in the question to which the partner acted as a researcher who elicited responses from this participant.

Analysis of Data
The statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 20.0 software (PASW Statistics for Windows, SPSS Inc, Chicago, IL, USA). Time series data of Respiratory Rate intervals (heartbeat interval) were formalized from the HOLTREC monitor (Nihonkoden, Tokyo, Japan) using HOLTREC (Nihonkoden), and the HRV. Data from these instruments were analyzed using MemCalc/Chiram3 (GMS Co., Tokyo, Japan).

The HRV spectral analysis (LF/HF ratio, HF power, and 1/f fluctuation) to assess the association between rehabilitation, recreation and intentional communication were performed. In order to obtain the accuracy of analyzed data, the researcher included observational data during data collection/measurement. HRV was evaluated by spectral analysis to assess sympathy-vagal balance.

For analysis of 1/f fluctuation, this was calculated using the slope of the regression line that relates to the log of the spectral amplitude to the log of the frequency ranging from 0.008, to 0.15 Hz at 4-min intervals. This regression is referred to as a 1/f plot. The absolute slope of the regression line is equal to the component x approaches -1, the autonomic nervous condition indicated a pleasant mood. However, when the x-value which was close to 0 or when almost flat regression line was obtained, such a status can be considered to be white noise (Ochi, Nomura, Okamura, Yano, Saito, Nakaya, & Ito, 2002).

The value of the LF/HF ratio and HF power were averaged. Each of the daytime activities, as intervention, obtained the following results: mean of LF/HF ratio and HF power compared with baseline data. Intervention times were as follows: rehabilitation (exercise) was 10 minutes, rehabilitation (thermotherapy) was 40 minutes, recreation was 50 minutes, and intentional communication was thirty minutes. Also, in order to obtain the accuracy of analyzed data, other than observation, data was also collected regarding the participant’s sleep condition and physical condition while wearing the monitors.

Ethical Considerations
Data was managed according to the Private Information Protection Law, with approval from the Tokushima University Hospital Ethics Board (approval number 2039). Participant was assured that her personal information would be protected, reported in aggregate, and used only for research purposes. The purpose and methods used in the study were explained and informed consent was obtained.

Results
Table 1 shows the changes in autonomic nervous activity. During the rehabilitation (exercise), recreation, and intentional communication, the mean LF/HF ratio was increased compared with the baseline. Also, during the rehabilitation (exercise), recreation, and intentional communication, the mean value of HF power was decreased. However, both mean LF/HF ratio and HF power was increased during the rehabilitation (thermotherapy).
Table. 1 Changes in Mean of LF/HF ratio and Mean of HF of Elderly Person with Dementia.

<table>
<thead>
<tr>
<th></th>
<th>LF/HF (ratio)</th>
<th>HF (msec²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BL</td>
<td>Mean</td>
</tr>
<tr>
<td>Rehabilitation (exercise)/10 minutes</td>
<td>0.2</td>
<td>0.3 (+)</td>
</tr>
<tr>
<td>Rehabilitation (chemotherapy)/40 minutes</td>
<td>0.2</td>
<td>0.5 (+)</td>
</tr>
<tr>
<td>Recreation/50 minutes</td>
<td>0.2</td>
<td>1 (+)</td>
</tr>
<tr>
<td>Intentional communication/30 minutes</td>
<td>1.1</td>
<td>1.5 (+)</td>
</tr>
</tbody>
</table>

LF/HF ratio means high-frequency to low-frequency ratio. HF means high-frequency. BL means Base line. (+) indicates increased of LF/HF ratio or HF after intervention. (-) indicates decreased LF/HF ratio or HF after intervention.

Power spectral density (PSD) was plotted, using data from 10:00 am to 10:00 am of next day (See figure 1). The 1/f fluctuation during rehabilitation, recreation, intentional communication, and sleep were -1.67, -1.48, -1.54, and -1.01, respectively. The 1/f fluctuation daytime values changed in the -1.5 neighborhood but a substantial change was not observed.

![Figure 1](image)

Figure 1 Slope of the f² plot of power spectral density (PSD): during rehabilitation, recreation, intentional communication, and sleep.
Discussion

It was considered that this participant’s sympathetic nerve activity has been activated by rehabilitation (exercise). Portugal (2013), mentioned that physical exercise (strong exercise such as aerobics exercises) may improve both mood and adherence to an exercise program in healthy individuals and might modulate both the performance and mental health of athletes. Thus, this participant received the same procedure of rehabilitation three times a week. It seemed that this rehabilitation procedure positively influenced the physical effects on this participant. Also, it was considered that this rehabilitation (exercise) effect to increase sympathetic activity and inhibit parasympathetic activity, such activities may have had a positive influence of controls homeostasis (Ueno, Hamada, Moritani, 2002). Moreover, this participant showed increased sympathetic nerve activity and parasympathetic nerve activity decreased by intentional communication.

Both sympathetic and parasympathetic activities were increased during the rehabilitation (thermotherapy). This state was considered comfortable tension by thermotherapy.

Camberg (1999), reported in the case study, that mental activity of patients with Alzheimer’s disease is influenced by a stimulating conversational experience. Communication is difficult for cognitively impaired elderly person with dementia. Due to the role of the autonomic nervous system in controlling physiological changes in the presence of external stimuli, the activity of this system is correlated with changes in affective and psychological states (Kushki, Andrews, Power, King, & Chau, 2012). This participant’s autonomic nervous activity showed the possibility of effective valuation for intentional communication. (Kemper, & Shaltout, 2011).

In this study intentional communication was determined between the elderly participant and the nurse (as researcher). It was thought that this process influenced the cognitive activity of the participant as claimed: “She talked about herself in the conversation”, “She expressed according to actual/current” and “After speaking, she got the nurse’s direct reactions.” During intentional communication, LF/HF ratio was increased when participant did not receive physical exercise. It was estimated that intentional communication had a positive effect on autonomic nervous activity.

The daytime 1/f fluctuation indicated around 1.5 and 1/f fluctuation in the night indicated around 1.0 in this participant (See figure 1). In daytime, 1/f fluctuation did not reach relaxation state as much as during sleep. This suggested that interventions by rehabilitation, recreation and intentional communication were enhancing daytime activity of the participant. It was also thought that all the interventions affected the sympathetic nervous activity and parasympathetic nerve activity. 1/f fluctuation was -1.01 at the time of sleep, and can be considered a relaxed state. With each intervention not all processes reached the relaxed state especially, the recreation procedure using calligraphy although this was considered to provide an important motivation for her. When the recreational activity was done, the 1/f fluctuation result was -1.48. This showed similar results with the relaxation state as compared with other daytime intervention (Park, Tsunetsugu, Kasetani, Morikawa, Kagawa, & Miyazaki, 2009).

Limitations

It is necessary to study these individual interventions. Moreover, autonomic nervous activities
are often only limited with effects on cardiac beats rate especially for elderly people. While most elderly people have cardiac disorders, it was thought necessary to include various parameters to determine potential effects of interventions designed for the elderly for the purpose of increasing daytime activities and preventing daytime somnolence. Autonomic nervous system data through physical measurements as in cardiac beats and wave frequencies provide more efficient ways to illustrate evidence-based interventions.

**Conclusion**

This study exhibited data using physical evidence through measurements that show numerical data. Three daytime activities were used as an intervention: Rehabilitation, recreation, and intentional communication. Especially for nursing homes, it was found that intentional communication is an excellent option that nurses can use to increase daytime participation, decrease daytime somnolence thereby increasing physical activities. With this data it showed that nocturnal sleep among institutionalized elderly patients with dementia can be enhanced. Increasing daytime activities provides critical evidence to support nursing activities success.

**References**


