高齢者診療をめぐる現場の知識と実践の技

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大学で臓器の専門医として臨床で腕をふるい，教職も務め，「最近どの診療科も高齢者が増え，どの科も老人を診ているので，特に老年内科などという科はいらない」と認識し，公式にも発言していた方が，定年後，老人保健施設の医師になった．入所者から「先生，腰が痛く，トイレが近く，夜中に起きてしまうからなんとかしてください」と言われ，職員から「同じことを何度も聞くし，夕方には不穏になります，食事時にむせることも増えてきました」とも追加情報があった．「整形，泌尿器，精神科，耳鼻科など受診したのか？」と職員に聞くと，「退所しなくては受診できません」と言われ，困っていると，入所者に「先生，年寄りのこと何も知らないね」と容赦なくつぶやかれ，胸に堪えた．

このように老年医学の専門医であれば，1人でごく普通に日常診療で複数の老年症候群の診断と治療，生活指導までこなしていることが，専門診療科と異なる特色である．

本書は，前記のエピソードとまったく正反対の，医師人生後半を老人保健施設で過ごした「達人」による教科書である．高齢者医療の現場で従来の内科では解決がつかない症状に出会い，残念なことに老年医学のテキストも実践的記述が不十分なため，即戦力にならない．こんな時，外国文献に当たり，看護師の工夫を拾い，独自のアイデアを実践して，10年かけて積み上げたら立派な教科書ができていたということである．

高齢者医療は複数の疾患が合併し，症状も内科以外の各科にわたる複雑な分野であり，複雑性の克服は以前から課題であった．私も困難な上流からようやく一定の境地の中流に辿り着いたと思っていたが，多くの重要なことを見落としていたようだ．川岸に立つ賢人は，老人保健施設でゆっくり逍遙し，高齢者医療の「徒然草」をまとめあげている．専門家以外も一読に値する名著である．

CLINICAL INVESTIGATIONS

Fall Prevention Using Olfactory Stimulation with Lavender Odor in Elderly Nursing Home Residents: A Randomized Controlled Trial

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OBJECTIVES: To investigate the effects of lavender olfactory stimulation intervention on fall incidence in elderly nursing home residents.

DESIGN: Randomized placebo-controlled trial.

SETTING: Three randomly selected nursing homes in northern Japan.

PARTICIPANTS: One hundred and forty-five nursing home residents aged 65 and older.

INTERVENTION: Participants were randomly assigned to the lavender (n = 73) or placebo group (n = 72) for a 360-day study period. The lavender group received continuous olfactory stimulation from a lavender patch. The placebo group received an unscented patch.

MEASUREMENT: The primary outcome measure was resident falls. Other measurements taken at baseline and 12 months included functional ability (assessed using the Barthel Index), cognitive function (Mini-Mental State Examination (MMSE)), and behavioral and psychological problems associated with dementia (Cohen-Mansfield Agitation Inventory (CMAI)).

RESULTS: There were fewer fallers in the lavender group (n = 26) than in the placebo group (n = 36) (hazard ratio (HR)=0.57, 95% confidence interval (CI) = 0.34–0.95) and a lower incidence rate in the lavender group (1.04 per person-year) than in the placebo group (1.40 per person-year) (incidence rate ratio = 0.51, 95% CI = 0.30–0.88). The lavender group also had a significant decrease in CMAI score (P = .04) from baseline to follow-up in a per protocol analysis.

CONCLUSION: Lavender olfactory stimulation may reduce falls and agitation in elderly nursing home residents; further research is necessary to confirm these findings. J Am Geriatr Soc 60:1005–1011, 2012.

Key words: fall prevention; lavender; nursing home residents

Falls are recognized as a major problem in community-dwelling elderly adults and even more so in frail elderly adults residing in institutions.[1,2] Approximately half of nursing home residents fall annually, two to three times that of community residents.[3] Falls are associated with morbidity and mortality in nursing home residents and linked to poorer overall functioning. A high risk of falling can considerably compromise the ability to perform activities of daily living (ADLs) and participate in social activities.[4] Reducing or minimizing the risk of falling can positively affect residents' quality of life.

Important underlying risk factors for falls include lower extremity weakness, gait and balance instability, poor vision, cognitive and functional impairment, and sedating and psychotropic medications.[1] Cognitive impairment is a strong risk factor for falls in nursing homes that may increase the risk of falls in multiple ways through the behavioral and psychological symptoms of dementia (BPSD), as well as gait and balance disturbances.[5–7]

A systematic review revealed that effective measures to prevent falls in nursing homes are seriously lacking.[7] Some challenges to incorporating fall prevention into practice include intervention feasibility, staff time constraints, competing demands, and inadequate reimbursement.[8,9]

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DOI: 10.1111/j.1532-5415.2012.03977.x

0002-8614/12/$15.00

Other barriers include a perceived lack of skills by healthcare professionals in managing complex, multifactorial health conditions and a lack of coordination in the nursing home setting. To overcome these difficulties, a new innovative, easy-to-execute intervention is warranted.

It is hypothesized that lavender (*Lavandula angustifolia*), used in aromatherapy as a relaxant, has multiple ameliorating effects on fall-related risk factors in elderly adults. A previous study showed that olfactory stimulation using lavender oil improved balance in elderly people.[10] In addition, another recent study reported that gait performance as measured using the Timed Up and Go test and 10-m walking speed significantly improved after exposure to lavender olfactory stimulation.[11] Although these studies demonstrated a transient effect of lavender olfactory stimulation, long-term exposure to continuous lavender olfactory stimulation has not been investigated. It is conceivable that, if individuals were exposed continuously to lavender olfactory stimulation, the stabilizing effects of lavender odor on gait performance might prevent falls in frail elderly people.

Lavender odor has soothing properties affecting anxiety and agitation underlying BPSD.[12,13] BPSD, such as physically nonaggressive behaviors (including pacing and wandering) and aggressive behaviors (leading to increases in prescription neuroleptic medications), may lead to and increase in fall risk. Because of the difficulty in treating individuals with BPSD, prescription tranquilizers and other psychotropic medications are common,[14,15] but such medications have shown modest efficacy but can have adverse effects such as confusion, gait disturbance, and falls. Therefore, increasingly more attention is being paid to nonpharmacological interventions specific to agitation. A recent review identified aromatherapy with lavender as a potential treatment for BPSD in nursing home residents.[16]

Olfactory stimulation with lavender may prevent falls in nursing home residents by ameliorating behavioral and psychological problems and consequently reducing the need to prescribe psychotropic medications, thereby ameliorating gait and balance disorders. The aim of this study was to test the effects of continuous lavender olfactory stimulation on the incidence and risk of falls in elderly nursing home residents. To this end, a randomized placebo-controlled trial was conducted using a paper patch with or without lavender attached daily by care staff to the inside of the clothes near the neck of nursing homes residents.

METHODS

Study Design, Participants, and Setting

The trial was conducted in three nursing homes randomly selected from 24 nursing homes in Aomori city, northern Japan. Inclusion criteria for eligible subjects were aged 65 and older and the ability to transfer independently regardless of assistive devices used. Recruitment occurred between September 10, 2009, and January 27, 2010. Of the 155 residents meeting the eligibility criteria, 10 were excluded; three did not provide informed consent, three moved before the trial began, and four had pica disorder. Residents with pica disorder, the unusual desire to eat "unnatural" things for food, were excluded because of the risk that they would eat the patch.

In each nursing home, the eligible residents were randomized to the lavender group or placebo group at a 1:1 ratio. An independent statistician performed resident allocations using computer-generated randomization of numbers at each nursing home. Treatment allocation status was delivered to the head nurse at each nursing home, and patches were prepared accordingly. Participants and study staff were blinded to the treatment groups and outcome measurements. One hundred and forty-five residents were randomized: 73 to the lavender group and 72 to the placebo group.

The ethics board of Tohoku University Graduate School of Medicine approved the study protocol, and the study design took into account the principles set out in the Helsinki Declaration (Seoul, 2008). The protocol was registered to UMIN Clinical Trials Registry identifier (UMIN000004222).

Intervention

Lavender olfactory stimulation was provided using a commercially available white patch (1 cm × 2 cm, Aromaseal Lavender; Hakujuji Co., Tokyo, Japan). This patch, attached to the inside of the resident's clothes near the neck, was originally developed to make busy and stressful people relax by providing continuous olfactory exposure to lavender for 24 hours. The odor is so faint that only the person wearing the patch can sense it. The price of one patch is 25 cents U.S. The placebo patch was an Aromaseal that had not been processed and was unscented. Nursing home staff, blinded to which Aromaseal was the placebo, affixed the lavender or placebo patch to the resident's clothing and replaced the patch daily. The head nurse prepared the appropriate patches and distributed them to the nursing home staff accordingly. Residents wore the patch for the whole day. At the time the patch was changed, the nursing home staff confirmed the existence of the prior day's patch; if the patch was missing, it was reported. The intervention finished 360 days after the start unless a resident dropped out. The final participants finished follow-up on January 14, 2011.

Measurements

The primary outcome measure was resident falls. For this study, a fall was defined in accordance with the World Health Organization's definition: "an event which results in a person coming to rest inadvertently on the ground or floor or other lower level."[17,18] The nursing home staff, blinded to group allocation, were trained to identify falls according to this definition and recorded falls daily using fall calendar sheets. The head nurse supervised the recording of falls regularly, and the calendar sheets were audited monthly to ensure agreement with incident reports. Individual nursing notes were also cross-checked for duplication and missed falls.

Trained research assistants, blinded to group allocation and information from previous evaluations, collected demographic and behavioral measures at baseline and 12-month follow-up. Behavioral measurements included the Cohen-Mansfield Agitation Inventory (CMAI) to quantify

BPSD,[19] the Barthel Index to assess level of functional ability, the MMSE to assess cognitive function, and the Vitality Index to assess activity of daily living (ADL)-related vitality.[20] The resident and caregiver assessed fall history in the previous year, and the staff was consulted and nursing notes and resident charts reviewed. To predict the probability of falling, visual, transfer, and mobility status were assessed using the St. Thomas's Risk Assessment Tool in Falling Elderly Inpatients (STRATIFY).[21] Medication status was assessed from medical chart reviews.

Statistics

Initial comparisons of outcome measures between groups were performed using chi-square tests or Mann–Whitney tests, as appropriate. Kaplan–Meier plots were used to compare time to first fall between groups.

Analyses for main outcomes, including time to first fall and number of falls per person-year, were based on an intention-to-treat analysis. Kaplan–Meier analyses and log-rank statistics were used to compare the proportion of fallers to non-fallers over time between groups. For consideration of covariance in time to first fall analysis between groups, a multivariate Cox proportional hazards regression was performed. A comparison of the number of falls per person-year between groups was performed using a multivariate Poisson regression model regarding the observation time as the offset variable. To confirm robustness in the Poisson regression model, the standard errors of each coefficient were adjusted by multiplying the unadjusted standard errors by the square root of the multiplicative overdispersion factor.

In multivariate analyses, age category (65–74 vs ≥ 75), sex, history of fall in a previous year (presence vs absence), cognitive function (MMSE score < 24 vs ≥ 24), agitation status (CMAI 22 = not agitated vs ≥ 23 = shows signs of agitation), transfer status (STRATIFY transfer and mobility score 0, 1, 2, 5, 6, or 3, 4), visual status (STRATIFY 1 or 2), number of medications (<5 vs ≥ 5), and use of tranquilizers (yes vs no) were regarded as possible covariates for the Model 1 multivariate analysis. In the Model 2 analysis, variables that achieved a significance level of $P < .2$ in the univariate analysis were subsequently included in a multivariate analysis using the stepwise forward Cox regression procedure and the Poisson regression procedure, respectively. To elucidate the mechanisms underlying the effects of lavender olfactory stimulation, an analysis for secondary outcomes, such as changes in CMAI, Barthel Index, MMSE, and Vitality Index were performed using a per protocol analysis. Normality of the data was assessed using the Shapiro-Wilk test. Comparisons between groups were performed using the Mann–Whitney test. Comparisons within groups at different time points were performed using the Wilcoxon signed-rank test or the paired Student *t*-test.

The analysis of outcomes for fallers and falls (Table 2) was done on the intention-to-treat analysis set, whereas the comparison of treatment groups at baseline and follow-up (Table 3) used the per protocol analysis set. All *P*-values were two-sided to detect a significance level of $P < .05$. Analyses were performed using SAS software version 9.2 (SAS Institute. Inc., Cary, NC).

Sample Size

To calculate the required sample size, the number of falls per person-year was focused on, based on data from similar nursing homes in Japan.[22] When the sample size in each group is 69, with a total number of events required (E) of 55, an exponential maximum likelihood test of equality of survival curves with a .05, two-sided significance level will have an 80% power to detect the difference between a placebo exponential parameter (l_1) of 0.8500 and an active exponential parameter (l_2) of 0.4000 (constant hazard ratio (HR) = 2.125); this assumes an accrual period of 0.10, a maximum follow-up time of 1.00, and no dropouts.[23]

RESULTS

A flowchart of enrollment, randomization, and follow-up is shown in Figure 1. No significant differences were observed between the lavender and placebo groups in the proportion who withdrew or in their reasons for withdrawal. No participants refused the lavender-scented patch, and there were no adverse effects reported due to exposure to the lavender. The baseline and demographic characteristics of residents allocated to each group are summarized in Table 1. The groups did not differ significantly according to age or risk factors for falls. No participants had missing values on primary outcome measures before death or discharge from nursing homes.

There were 62 falls reported during the follow-up period (Table 2); only two resulted in injury, a subdural hemorrhage in the lavender group and a femoral neck fracture in the placebo group. The percentages of participants who

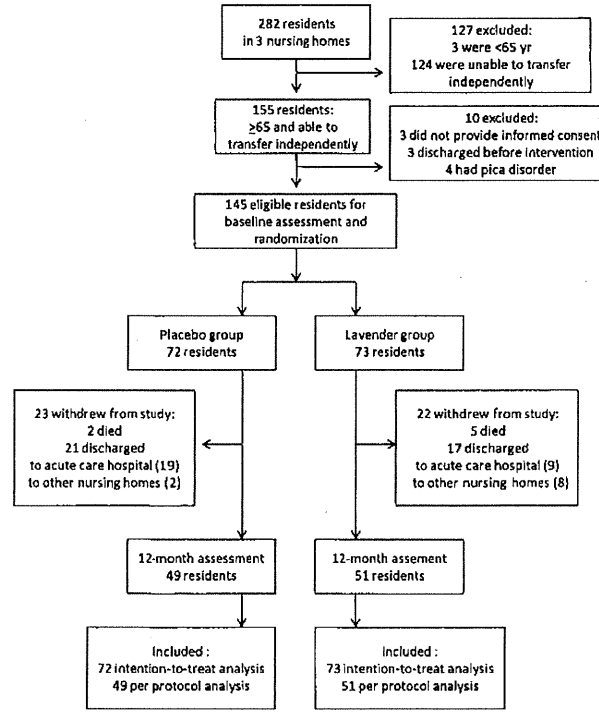

Figure 1. Flowchart for enrollment, randomization, and follow-up of study participants.

Table 1. Baseline Characteristics of Participants (n = 145)

Characteristic	Placebo, n = 72	Lavender, n = 73	P-Value
Age, mean ± SD	84.1 ± 7.7	84.2 ± 7.8	.93[a]
≥75 years, n (%)	62 (86.1)	64 (87.7)	.81[b]
Female, n (%)	13 (18.1)	14 (19.2)	>.99[b]
Comorbidity, n (%)			
History of stroke	23 (31.9)	24 (32.9)	>.99[b]
Diabetes mellitus	12 (16.7)	18 (24.7)	.31[b]
Osteoarthritis	1 (1.4)	1 (1.4)	>.99[c]
Parkinson's disease	1 (1.4)	1 (1.4)	>.99[c]
Visual impairment	6 (8.3)	10 (13.7)	.42[b]
Barthel Index, mean ± SD	49.6 ± 19.2	50.3 ± 18.5	.82[a]
Mini-Mental State Examination score, mean ± SD	14.6 ± 8.1	15.3 ± 8.4	.51[a]
<24, n (%)	59 (81.9)	60 (82.2)	>.99[b]
Cohen-Mansfield Agitation Inventory score, mean ± SD	24.6 ± 6.9	24.2 ± 5.2	.61[a]
≥23, n (%)	18 (25.0)	23 (31.5)	.46[b]
Vitality Index, mean ± SD	8.1 ± 1.9	8.1 ± 2.0	.73[a]
History of falls, n (%)	30 (41.7)	31 (42.5)	>.99[b]
History of recurrent falls, n (%)	11 (15.3)	10 (13.7)	.49[b]
Transfer risk, n (%)	34 (47.2)	41 (56.1)	.32[b]
Mobility status[d], n (%)			
Walk without aids	52 (72.2)	53 (72.6)	.88[b]
Walk with aids	16 (22.2)	17 (23.3)	
Use a wheelchair	4 (5.6)	3 (4.1)	
Number of medications, mean ± SD	4.9 (2.7)	5.0 (2.3)	.85[a]
≥5, n (%)	37 (51.4)	37 (9.6)	>.99[b]
Prescription medications, n (%)			
Tranquilizer	15 (20.8)	10 (13.7)	.28[b]
Antidepressant	1 (1.4)	2 (2.7)	>.99[c]
Yokukansan	6 (8.3)	5 (6.8)	.77[b]
Diuretics	11 (15.3)	15 (20.5)	.52[b]
Antihypertensive	43 (59.7)	45 (61.6)	.87[b]
Antidiabetic drugs	7 (9.7)	11 (15.1)	.45[b]

SD, standard deviation.
[a] Mann–Whitney *U*-test.
[b] Chi-square test.
[c] Fisher exact test.
[d] Moving to the bathroom.

fell at least once during the 12-month study period were 35.6% (lavender group) and 50% (placebo). There were no significant differences observed when examining Kaplan Meier plots of time to first fall between treatment groups ($P = .11$) or in relation to tranquilizer use ($P = .16$).

The crude results of the Cox proportional hazards analysis on the intention-to-treat analysis set were not significant (Table 2), although after adjustment for covariates between the lavender and placebo groups, the differences for first fall were significant for Models 1 ($P = .04$) and 2 ($P = .03$). The HR of the intervention to placebo group was 0.59 (95% confidence interval (CI) = 0.35–0.99) after adjustment for age, sex, fall history, MMSE, CMAI, transfer and visual status, and tranquilizer use (Model 1). The HR decreased to 0.57 (95% CI = 0.34–0.95) after adjustment for MMSE, fall history, and transfer (Model 2).

Table 2. Outcomes for Fallers and Falls

Outcome	Placebo, n = 72	Lavender, n = 73	P-Value
Intervention days, mean ± standard deviation	313.8 ± 76.3	287.5 ± 114.5	.78[a]
Faller, yes/no	36/36	26/47	.08[b]
Recurrent faller, yes/no	23/49	14/59	.08[b]
Total number of falls, n	88	46	
Fall rate per person-year	1.40	1.04	
Hazard ratio for fallers (95% CI)			
Crude	1	0.67 (0.40–1.10)	.11[c]
Adjusted (Model 1)	1	0.59 (0.35–0.99)	.04[c]
Adjusted (Model 2)	1	0.57 (0.34–0.95)	.03[c]
Incidence rate ratio for fallers (95% CI)			
Crude	1	0.57 (0.32–0.99)	.04[d]
Adjusted (Model 1)	1	0.54 (0.31–0.95)	.03[d]
Adjusted (Model 2)	1	0.51 (0.30–0.88)	.02[d]

CI, confidence interval.
Model 1 adjusted for age, sex, fall history, Mini-Mental State Examination (MMSE) score, Cohen-Mansfield Agitation Inventory, transfer status, visual status, tranquilizer. Model 2 adjusted for MMSE score, fall history, transfer (selected using stepwise variable selection).
[a] Mann–Whitney *U*-test.
[b] Chi-square test.
[c] Cox proportional hazard regression.
[d] Poisson regression model.

The number of falls per person during the follow-up period ranged from zero to five in the lavender group and zero to seven in the placebo group. As shown in Table 2, the incidence rate for the lavender group was significantly lower than for the placebo group even before adjustment for possible covariates ($P = .04$). The incidence rate ratio (IRR) in crude analysis was 0.57 (95% CI = 0.32–0.99). After adjustment for age, sex, fall history, MMSE, CMAI, transfer and visual status, and tranquilizer use (Model 1), the IRR decreased to 0.54 (95% CI = 0.31–0.95). After adjustment for MMSE, fall history, and transfer status (Model 2), the IRR further decreased to 0.51 (95% CI = 0.30–0.88).

Table 3 shows the results of per protocol analyses for changes in functional ability (Barthel Index), cognitive function (MMSE), volition (Vitality Index), and agitation (CMAI) after 12 months of treatment. No differences were observed between groups at baseline or 12 months for any of the indexes analyzed. The lavender and placebo groups showed a significant decrease in cognitive functioning at 12-month follow-up. When comparing CMAI scores at 12-month follow-up, the lavender group showed a significant decrease in agitated status ($P = .04$) from baseline, but the placebo group did not. The Barthel and Vitality indexes did not change significantly from follow-up in either group. The average number of medications at 12-month follow-up was 4.73 ± 2.17 in the lavender group and 4.57 ± 2.17 in the placebo group.

During the study period, one resident from each group was newly prescribed tranquilizers. At 12-month follow-up, six residents in the lavender group and 10 in the placebo group were prescribed tranquilizers. No significant difference was observed in the number of residents

Table 3. Comparison of Groups at Baseline Versus Follow-Up in Per Protocol Analyses

	Placebo (n = 49)			Lavender (n = 51)		
	Baseline	Follow-Up		Baseline	Follow-Up	
Test	Mean ± SD		*P*-Value	Mean ± SD		*P*-Value
Barthel Index	**50.0 ± 1.91**	**47.5 ± 21.0**	**.09[a]**	**49.6 ± 18.3**	**49.6 ± 18.6**	**.94[b]**
Mini-Mental State Examination score	14.6 ± 21.0	11.9 ± 8.4	<.001[a]	15.3 ± 9.2	13.4 ± 9.1	<.001[a]
Cohen-Mansfield Agitation Inventory score	**24.5 ± 6.7**	**24.0 ± 3.7**	**.82[a]**	**24.3 ± 5.4**	**22.9 ± 2.3**	**.04[a]**
Vitality Index	8.2 ± 1.7	8.1 ± 2.3	.76[a]	8.2 ± 2.0	8.1 ± 2.2	.90[a]

SD, standard deviation.

No difference was observed between groups at baseline and after 12-month interventions for each index according to the Mann–Whitney *U*-test. *P*-value was comparison between baseline and post intervention according to [a]Wilcoxon rank test or [b]paired Student t-test.

prescribed tranquilizers between the groups at baseline ($P = .78$) or the end of the trial ($P = .71$). One resident from the lavender group and one from the placebo group took vitamin D (1 μg) daily; neither of them fell during the study period.

DISCUSSION

This study highlights the beneficial effects of lavender odor on fall prevention in elderly nursing home residents. This multifacility randomized placebo-controlled study showed that daily use of a lavender patch was associated with a lower incidence rate of falls. Although not significant, the number of residents who fell during the observation period ($P = .08$) and those who fell two or more times during the 12-month study ($P = .11$) was less in the lavender group. After adjustment for possible confounding factors, the proportion of residents who were nonfallers over time was significantly lower in the lavender group.

The mechanism by which lavender prevents falls is speculative. Lavender oil is used extensively in aromatherapy and is described as therapeutic for insomnia, headaches, migraines, anxiety, nervousness, and melancholy.[24] Lavender has been used as a sleep aid and can be a useful nonpharmacological alternative to traditionally prescribed medications for insomnia, which are strong risk factors for falls in elderly adults.[25] Because lavender is thought to have soothing properties, it is logical to assume it may also affect the anxiety and agitation that underlie BPSD. The lavender group showed a significant decrease in agitated status, whereas the placebo group did not, suggesting the involvement of a soothing effect of lavender odor. There was not significant less tranquilizer use in the lavender group than in the placebo group, so tranquilizer use was not viewed as a potential confounding factor in the present study. The frequency of tranquilizer use was lower in the current study than in other studies in nursing homes, probably because of Yokukansan use, a traditional Asian medicine commonly prescribed to treat BPSD.[26,27] Although there was no difference in Yokukansan use between the lavender and placebo groups, further study is warranted to elucidate the relationship between Yokukansan, tranquilizers, and lavender olfactory stimulation.

Another possible explanation for why lavender prevents falls might be attributed to its stabilizing effects on balance. In previous work, the application of olfactory stimulation by an essential oil such as lavender and black pepper during quiet standing was associated with less postural sway in frail elderly adults.[10] Multiple sensory and motor mechanisms ranging from peripheral to cortical sensory-motor integration regulate the control of posture and motion.[28] In addition to vestibular afferents, visual and proprioceptive inputs contribute to postural stability. Although several multisensory vestibular cortical areas, which process signals provided from multiple thalamic nuclei, were identified using imaging studies, the core vestibular cortical region is thought to be located in the insular cortex.[29] Odor is one of the strongest stimuli over a wide area of the cerebral cortex including the insular cortex.[30] Olfactory stimulation may stabilize balance by activation of the insular cortex. Unfortunately, a limitation of the present study is the lack of balance data. Further studies are needed to clarify the contribution of the balance-stabilizing effects of lavender on fall prevention.

Only two residents were prescribed vitamin D (1 in each group). Vitamin D supplementation is an easy pharmacotherapy to prevent falls in nursing home residents.[1,7] The current evidence recommends that vitamin D be prescribed in a dosage of 1,000 IU for nursing home residents. Vitamin D may be effective in reducing falls and increasing muscle strength in persons with severe vitamin D deficits,[1] but current evidence of risk reduction of falls with vitamin D supplementation is inconsistent.[7]

Several current guidelines recommend multifactorial risk assessment of falls and interventions customized to an individual's risk factor profile as a primary treatment strategy in community-dwelling elderly people.[1,31] Several randomized controlled trials have investigated the effectiveness of this strategy in nursing home residents,[32–39] and only some of the trials showed efficacy in reducing falls.[36–39] It is unclear whether differences in effectiveness may be attributed to a variation in the type of intervention or selection bias. The sample population recruited into trials may not be representative of the general elderly population (e.g., lack of studies that include participants with multiple comorbidities or cognitive decline). It is important to develop a suitable program for multifactorial intervention in each facility setting.

The present study has several limitations. First, it was conducted with nursing home residents, so results cannot be generalized to community-dwelling elderly people. Second, although the study showed that lavender olfactory

stimulation prevents falls in elderly nursing home residents, it was not powered to detect a clinically relevant reduction in injurious falls because the incidence of such events was low. Third, as is the nature of odor application, nursing home residents and staff may not have been completely blinded, which may have resulted in reporting bias. Finally, the olfactory functioning of the participants was not tested. Difficulty in identifying odor has been reported not only in individuals with Alzheimer's and Parkinson's diseases,[40] but also in elderly persons without cognitive impairment.[41] Therefore, it was possible there were residents who could not sense the lavender odor.

A meta-analysis showed that a multifactorial intervention including exercise training for balance stability reduced the risk and rate of falls in community-dwelling elderly adults.[25] Moreover, gradual withdrawal of some types of drugs for improving sleep, reducing anxiety, and treating depression have been shown to reduce the rate of falls.[25] Lavender olfactory stimulation acts on balance and psychological status, suggesting that it may have the ability to reduce falls in nursing home residents and community dwelling-elderly adults.

CONCLUSION

Daily olfactory stimulation with lavender may prevent falls in elderly nursing home residents. Further studies with large sample sizes comprising multiple ethnic groups are warranted to confirm these findings.

ACKNOWLEDGMENTS

We would like to thank the residents and nursing home staff who participated in the study.

This trial was supported by the Research Funding for Longevity Sciences (22 2) from the National Center for Geriatrics and Gerontology, Japan, and the Ministry of Education, Culture, Sports, Science and Technology, Japan (Grants 20590694, 21390219); the Ministry of Health, Labor and Welfare, Japan (H21-Choju-Ippan-005, H22-Junkanki-shi-Ippan-001); the Mitsui Sumitomo Insurance Welfare Foundation; and Suzuken Memorial Foundation, a Grant-in-Aid (Houga) for Aomori University of Health and Welfare, Aomori, Japan.

Ms. Shannon Freeman is generously funded by the Canadian Institute of Health Research Frederick Banting and Charles Best Doctoral Research Award 2009–2013.

Conflict of Interest: None of the authors have any financial or personal conflicts of interest, or relationships and affiliations relevant to the subject of this manuscript.

Author's Contributions: All authors were involved in the conception and design of this study. YS, SE, and TE: recruited the study population and conducted the clinical trial. SE: conceived the original idea for the study, supervised in the conception and design of the study, and drafted the manuscript. NT: advised on biostatistical methodology and provided critical revisions to the manuscript. KT, SF, HA, and MK: assisted with analysis of the data and critically reviewed the manuscript. All authors read and approved the final manuscript.

Sponsor's Role: The funding organizations had no role in the design or conduct of the study; collection, management, analysis, or interpretation of the data; or preparation, review, or approval of the manuscript.

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Geriatr Gerontol Int 2012; 12: 563–572

LETTERS TO THE EDITOR

New dorsiflexion measure device: A simple method to assess fall risks in the elderly

Dear Editor,

Hip fracture is the third leading cause yielding bedridden status in Japan, and more than 80% of hip fractures are reported to be caused by falling. There are a variety of causes for falls in the elderly, and one of the significant causes is the inability to lift their toes when they walk. Here, we show a new device to measure dorsiflexion angle, an instrument that we developed to assess fall risks in the elderly.

Participants were requested to stand up straight and step back until the hip leaned on the wall (Fig. 1a). The fulcrum of the instrument was adjusted to the center of the external malleolus (Fig. 1b). The arm of the instrument was set to stay level, adjusting the branching thin arm placed on the ridge of the dorsum of the foot. Then, participants were asked to dorsiflex as much as possible. The mean time to measure bilateral dorsiflexion angles was within 5 min.

We measured dorsiflexion and Fall Risk Index (FRI),[1,2] including the history of falls within the past year, in 131 women (46–89 years, mean age 78.0 ± 7.1 years) and 88 men (46–93 years, mean age 76.2 ± 8.6 years) who visited the fall prevention clinic in Kyorin University Hospital. The occurrence of falls within the past year was 35.6%. Falls occurred 2.0 ± 0.1 times in fallers within 1 year, and women fell more frequently than men (42.7% *vs* 25.0%, $\chi^2 = 7.2$, $P \leq 0.01$). The average FRI score was 6.7 ± 3.4 in non-fallers and 10.6 ± 3.0 in fallers ($P < 0.0001$). Women showed a higher FRI score than men (8.8 ± 3.6 *vs* 7.0 ± 3.8, $P = 0.003$).

This new device appears promising in detecting the high-risk group of fallers, because the dorsiflexion angle was significantly smaller in fallers than non-fallers (right 9.6 ± 8.4 *vs* 13.7 ± 9.6 degrees, $P = 0.012$; left 10.0 ± 8.5 *vs* 14.2 ± 9.8 degrees, $P = 0.014$). Furthermore, the occurrence of falls was more frequent as the dorsiflexion angle decreased in women ($\chi^2 = 6.4$, $P = 0.042$; Fig. 1c), and half of the subjects, whose dorsiflexion angle was less than 10 degrees, experienced falls within a year.

Previously, it was reported that hip fractures occur more frequently in women than men, even though the incidence rate of falls was comparable until the age of 90 years. This is considered to be a result of the higher prevalence of osteoporosis in women.[3] In contrast, the present study found that women less than 90 years-of-age fell more frequently than men in the Japanese population of this age group. We also found that the FRI score was higher in women than men, as has been shown previously.[4] In addition, dorsiflexion angle was

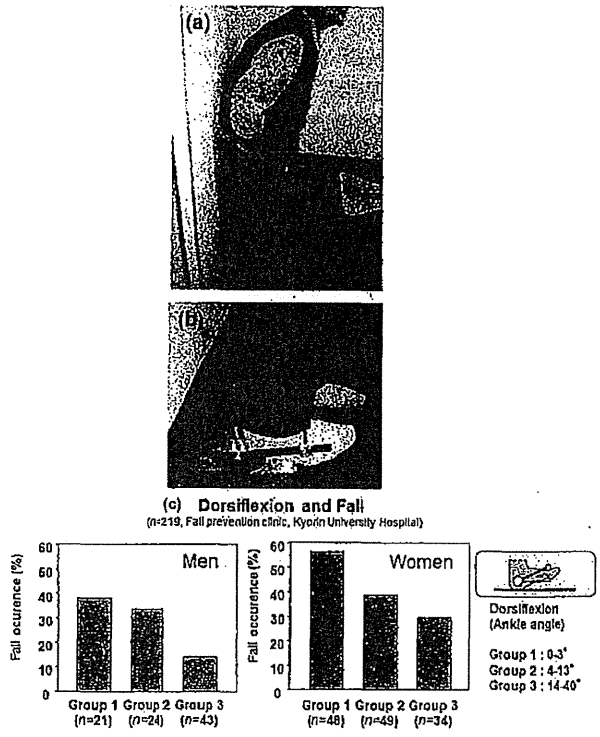

Figure 1 (a,b) How to measure dorsiflexion angle using a dorsiflexion measure device. (c) The relationship between dorsiflexion angle and the occurrence of falls within the past year. In men and women respectively, participants were grouped by tertile according to the dorsiflexion angle.

smaller in women than men (right 10.3 ± 8.4 *vs* 15.2 ± 10.1 degrees, $P = 0.0001$; left 11.0 ± 8.5 *vs* 15.2 ± 10.4 degrees, $P = 0.0013$), and a stepwise increase in the fall occurrence rate according to the level of dorsiflexion angle was evident in women (not significant in men). These results show that less ability to dorsiflex would partly explain the sex difference in the occurrence of falls and ensuing hip fracture.

The new dorsiflexion measure device we report here is easy and less time-consuming to use, and will be sure to help identify a high-risk group of fallers in the elderly.

Disclosure statement

This study was approved by the Ethics Committee of Kyorin University School of Medicine. Accordingly, written informed consent was obtained from all patients. All authors contributed significantly to this work and are

doi: 10.1111/j.1447-0594.2011.00787.x

in agreement with the content of the manuscript. This study was supported by a Health and Labour Sciences Research Grant (H21-Choju-Ippann005) from the Ministry of Health, Labour and Welfare of Japan.

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JAMDA xxx (2013) 1–6

JAMDA

journal homepage: www.jamda.com

Original Study

Priorities of Health Care Outcomes for the Elderly

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Keyword:
Geriatrics
quality of care
health care policy

A B S T R A C T

Objectives: Physicians are uncertain about what medical services should be provided to older and/or disabled patients. Better understanding of health outcome prioritization among health care providers and recipients may help the process of decision- and policy-making. For this purpose, surveys were conducted on priorities of health care outcomes for the elderly.
Design: Survey research.
Setting: Four groups of health care providers and four groups of health care recipients.
Participants: A total of 2512 health care providers and 4277 recipients.
Measurements: Questionnaires were sent to more than 8000 health care providers and more than 9000 health care recipients: geriatricians, physicians who commonly see older patients or work in long term care facilities, staff members and participants in adult day care, patients in outpatient geriatric clinics, family members of patients with dementia, and community-dwelling older adults. The questionnaire asked the subjects to rank 12 measures of health care outcomes.
Results: The mean response rate was 49%. All health care provider groups considered "improvement of quality of life" the most important. In contrast, in health care recipient groups, "effective treatment of illness," "improvement of physical function," and "reduction of carer burden" were given high priority, whereas "improvement of quality of life" was perceived as less important. All the groups, including health care providers and recipients, ranked "reduction of mortality" the least important, followed by "avoiding institutional care." Stratification analysis showed that the results did not differ by sex, nursing care level, or the existence of relatives who required nursing care, whereas age slightly influenced the order of high-ranked measures.

This study was supported by a Health and Labor Sciences Research Grant (H22-Choju-Shitei-009) from the Ministry of Health, Labor, and Welfare of Japan.

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http://dx.doi.org/10.1016/j.jamda.2013.01.009

Conclusion: Priorities of health care services and their differences between providers and recipients should be taken into account in the health care of older patients and the design of health care policies and research.

Japanese society has been rapidly aging owing to long life expectancy and a low birth rate.[1] People older than 65 comprised 23.8% of the population in 2012, which is expected to rise to 31.8% in 2030[2] and will be by far the highest in the world. Japanese physicians have been exposed to a high load of older patients, and management of older patients remains a major challenge. There are several reasons for this difficulty. Evidence is still largely lacking for older patients, especially for those older than 75 years, who account for 11.8% of the Japanese population.[2,3] Older patients are likely to have multimorbidities, or co-occurrence of two or more chronic conditions,[4] but application of disease-specific guidelines to older patients with multimorbidities may result in polypharmacy, an increased risk of adverse drug reactions, and poor outcomes.[5,6] At the same time, however, older patients are at increased risk of underuse of necessary medication, for fear of polypharmacy or complications.[7,8]

In an attempt to help optimize prescribing for older patients, investigators have devised numerous tools to guide clinicians, such as lists of indicated, beneficial medication or medication with high potential for harm.[9,10] Although these tools are helpful in reducing exposure of older patients to inappropriate medication and risk of adverse drug events,[11] they do not provide more general considerations, such as when or how to discontinue potentially inappropriate medications, how to balance risks and benefits of unlisted medication, or how to manage medication in special circumstances, such as palliative and hospice care where symptom control is of higher priority. Therefore, the process of determining the medication regimen is inevitably subjective and individualized, taking into account patients' cognitive, physical, and social function, remaining life expectancy, and the goals of care.

Unfortunately, few studies have examined the priorities of health care perceived by health care providers and recipients in geriatric medicine. One small study conducted in England more than 15 years ago showed that geriatricians and patients similarly gave high priority to reducing disability and improving quality of care, and low priority to reducing mortality.[12] However, the serious question of whether there may be a gap in priorities of health care between health care providers and recipients has been raised.[13,14]

Better understanding of health outcome prioritization among health care providers and recipients in geriatric medicine is necessary to help physicians, older patients, and their family members discuss the goals of care and to assist health policy makers in effectively using resources to address the needs of older patients. In this study, we aimed to obtain a comprehensive picture of the views of groups with an important stake in geriatric health care services (geriatricians, physicians who commonly see older patients or work in long term care facilities, staff members and participants in adult day care, patients in outpatient geriatric clinics, family members of patients with dementia, and community-dwelling older adults) on the relative priorities of different outcome measures that are relevant to geriatric clinical practice and health care policy.

Methods

Between September 2010 and October 2011, surveys were conducted in the following eight groups:

(1) All geriatricians (approximately 1500) board certified by the Japan Geriatrics Society
(2) A total of 5000 physicians randomly selected from the list of board-certified physicians in five subspecialties (two internal medicine subspecialties, two surgical subspecialties, and one other) with high exposure to older patients
(3) Physicians working in 800 long term care facilities that were randomly chosen from the nationwide list of long term care facilities
(4) Staff members working in adult day care at 400 randomly chosen long term care facilities as mentioned previously
(5) Participants in adult day care at the same 400 long term care facilities as mentioned previously
(6) Patients in geriatric outpatient clinics at five university teaching hospitals (the University of Tokyo, Kyorin University, Nagoya University, Kyoto University, and Tohoku University)
(7) Family members of patients with dementia who had been seen in geriatric outpatient clinics at four university teaching hospitals (Tohoku University was excluded because of the Tohoku Earthquake at the time of this survey)
(8) A total of 6000 community-dwelling, functionally independent (ie, not requiring nursing care provided by long term care

Table 1
Survey Methods and Number of Valid Answers in 8 Groups

Groups	Time of Survey	Survey Methods	No. of Questionnaires Sent	No. (%) of Valid Answers*
Health care providers				
Geriatricians	2010, Sep	By post	1500	619 (41)
Physicians in 5 subspecialties	2011, Oct	By post	5000	1305 (26)
Physicians in long term care facilities	2011, Oct	By post	800	384 (48)
Adult day care staff	2010, Sep	By post for each facility	400 facilities (2 per facility)	204†
Health care recipients				
Adult day care participants	2010, Sep	By post for each facility	400 facilities (5–10 per facility)	795†
Patients in geriatric outpatient clinics	2010, Sep	Distributed by physicians and returned by post	950	512 (55)
Family members of patients with dementia	2011, Oct	Distributed by physicians and returned by post	542	333 (61)
Community-dwelling older adults	2010, Sep	By post	6000	2637 (44)

*Responses with missing items or invalid answers were excluded.
†For adult day care staff members and participants, questionnaires were sent to each facility by post, where 2 staff members and 5 to 10 participants were offered the questionnaire; 123 facilities (31%) returned the completed questionnaires.

insurance) older adults randomly drawn from the community registers of two target areas (Kashiwa, Chiba Prefecture, a city close to Tokyo, and Sabae, Fukui Prefecture, a provincial city), from which men and women, 65 to 74 years and older than 75 years, were equally selected

Postal questionnaires were sent to all groups of physicians and community-dwelling old adults. For adult day care staff members and participants, questionnaires were sent to each facility, where two staff members and 5 to 10 participants were offered the questionnaire, to be completed on a voluntary basis. The completed questionnaires were gathered at each facility and then returned to us. Patients and family members of patients with dementia received the questionnaires from their physicians (Table 1).

The questionnaire asked about the relative priorities of 12 health care measures that were derived from a literature review and a previous Internet-based survey conducted by the National Center for Geriatrics and Gerontology in 2009 (in Japanese; http://www.ncgg.go.jp/pdf/itaku/21hokoku/20si-3.pdf). Each item was expressed as several words so as to help health care recipients understand the meaning. The respondents were asked to rank the measures in order of priority from 1 (most importance) to 12 (least important). To facilitate ranking the outcomes in order, they were prompted to choose and rank the three most important outcomes, then the three least important outcomes, and last, the six middle outcomes. Ties, or the same ranks, were not allowed.

To examine whether variation in the question wording could affect the results, we devised another version of the questionnaire with different wording for four items and sent that version to a randomly selected subset of participants; however, the results were almost identical (data not shown). We also tested whether the order of health care measures that appeared in the questionnaire would affect the results in a random subset of participants, but the responses to the reverse order questionnaire were similar to those of the original version (data not shown). Therefore, we analyzed the responses from different versions (wording and order) together.

The following information was also collected using the questionnaire: age and sex for all participants; specialty (internal medicine, surgery, psychiatry, or others) and years of experience for physicians; qualification and years of experience for adult day care staff; nursing care level (level of required nursing care: relatively independent, limited impairment, needing extensive help, or severely dependent) for adult day care participants; nursing care level and the existence of relatives who required nursing care for patients in geriatric outpatient clinics; nursing care level, morbid conditions, and the existence of relatives who required nursing care for community-dwelling older adults.

The study protocol was approved by the Ethics Committee of the Graduate School of Medicine, The University of Tokyo. Ethical approval for the surveys on patients in geriatric outpatient clinics and family members of patients with dementia was also obtained from the participating institutions.

Results

The mean response rate for the eight groups was 49%, which varied from 28% for board-certified physicians to 68% for family members of patients with dementia (Table 1). The analytic sample included a total of 2512 health care providers and 4277 recipients.

Tables 2 and 3 show the relative priorities of 12 measures of health care services from the highest importance to the lowest, with mean and 95% CI, perceived by health care providers and recipients, respectively.

All physician groups considered "improvement of quality of life" the most important, and the low mean value for this item across physician

Table 2
Health Care Providers' Priorities for Health Care Outcome

Rank Order	Geriatricians (n = 619)			Physicians from 5 Relevant Subspecialties (n = 1305)			Physicians in Long Term Care Facilities (n = 384)			Adult Day Care Staff (n = 204)		
	Outcome	Mean	95% CI	Outcome	Mean	95% CI	Outcome	Mean	95% CI	Outcome	Mean	95% CI
1	Improvement of quality of life	2.62	2.45–2.80	Improvement of quality of life	3.09	2.96–3.22	Improvement of quality of life	2.88	2.62–3.14	Improvement of quality of life	4.29	3.88–4.71
2	Patient satisfaction with care	4.37	4.15–4.58	Patient satisfaction with care	4.34	4.19–4.49	Patient satisfaction with care	4.60	4.32–4.88	Maintaining a high level of activity	4.35	3.96–4.73
3	Effective treatment of illness	4.80	4.53–5.07	Maintaining a high level of activity	4.64	4.48–4.80	Improvement of physical function	4.68	4.39–4.97	Reduction of carer burden	4.80	4.42–5.17
4	Maintaining a high level of activity	4.92	4.69–5.15	Improvement of physical function	5.25	5.08–5.42	Maintaining a high level of activity	4.73	4.43–5.03	Resolution of assessed problems	5.15	4.74–5.55
5	Improvement of physical function	4.94	4.71–5.18	Effective treatment of illness	5.32	5.13–5.52	Improvement of mental health	5.50	5.29–5.71	Improvement of mental health	5.26	4.86–5.65
6	Improvement of mental health	6.04	5.87–6.20	Reduction of carer burden	5.93	5.79–6.07	Resolution of assessed problems	5.77	5.51–6.04	Patient satisfaction with care	5.43	5.03–5.83
7	Resolution of assessed problems	6.39	6.17–6.61	Resolution of assessed problems	6.12	5.97–6.27	Reduction of carer burden	6.10	5.84–6.37	Improvement of physical function	5.83	5.42–6.25
8	Reduction of carer burden	6.45	6.27–6.64	Improvement of mental health	6.39	6.26–6.52	Effective treatment of illness	6.22	5.87–6.57	Improvement of social functioning	7.17	6.79–7.55
9	Efficient use of resources	7.83	7.67–8.00	Efficient use of resources	7.50	7.37–7.62	Efficient use of resources	8.15	7.95–8.35	Effective treatment of illness	7.41	6.95–7.87
10	Improvement of social functioning	8.80	8.62–8.98	Improvement of social functioning	8.69	8.56–8.82	Improvement of social functioning	8.20	7.95–8.44	Efficient use of resources	7.43	7.04–7.81
11	Avoiding institutional care	10.28	10.15–10.42	Avoiding institutional care	10.24	10.14–10.34	Avoiding institutional care	10.31	10.13–10.50	Avoiding institutional care	9.97	9.71–10.23
12	Reduction of mortality	10.56	10.37–10.76	Reduction of mortality	10.49	10.36–10.62	Reduction of mortality	10.85	10.67–11.04	Reduction of mortality	10.92	10.66–11.17

CI, confidence interval.

Table 3
Health Care Recipients' Priorities for Health Care Outcome

Rank Order	Community-Dwelling Older Adults (n = 2637)			Family Members of Patients With Dementia (n = 333)			Patients in Geriatric Outpatient Clinics (n = 512)			Adult Day Care Participants (n = 795)		
	Outcome	Mean	95% CI	Outcome	Mean	95%CI	Outcome	Mean	95% CI	Outcome	Mean	95% CI
1	Effective treatment of illness	4.23	4.11–4.36	Effective treatment of illness	3.04	2.76–3.32	Effective treatment of illness	2.79	2.58–3.00	Improvement of physical function	3.64	3.42–3.86
2	Reduction of carer burden	4.56	4.44–4.67	Improvement of physical function	4.49	4.19–4.78	Improvement of physical function	4.06	3.84–4.29	Effective treatment of illness	4.33	4.11–4.55
3	Improvement of physical function	5.24	5.13–5.36	Maintaining high level of activity	5.11	4.76–5.45	Improvement of quality of life	5.46	5.19–5.73	Reduction of carer burden	5.40	5.18–5.63
4	Maintaining high level of activity	5.88	5.76–5.99	Reduction of carer burden	5.29	4.98–5.61	Reduction of carer burden	5.52	5.28–5.77	Improvement of quality of life	6.08	5.86–6.30
5	Resolution of assessed problems	5.91	5.76–6.05	Improvement of mental health	5.53	5.24–5.82	Improvement of mental health	5.81	5.58–6.04	Maintaining high level of activity	6.12	5.88–6.37
6	Improvement of mental health	6.26	6.15–6.36	Improvement of quality of life	5.80	5.48–6.13	Maintaining high level of activity	5.97	5.66–6.28	Improvement of mental health	6.38	6.17–6.58
7	Improvement of quality of life	6.36	6.23–6.49	Resolution of assessed problems	5.98	5.69–6.27	Resolution of assessed problems	6.17	5.93–6.42	Patient satisfaction with care	6.44	6.24–6.64
8	Patient satisfaction with care	6.81	6.70–6.92	Patient satisfaction with care	6.01	5.70–6.31	Patient satisfaction with care	6.72	6.47–6.96	Resolution of assessed problems	6.45	6.26–6.65
9	Efficient use of resources	6.91	6.81–7.02	Efficient use of resources	7.49	7.21–7.76	Efficient use of resources	7.46	7.24–7.69	Efficient use of resources	6.57	6.36–6.77
10	Improvement of social functioning	7.44	7.32–7.56	Improvement of social functioning	9.17	8.90–9.45	Improvement of social functioning	8.42	8.18–8.65	Improvement of social functioning	8.22	8.03–8.42
11	Avoiding institutional care	8.43	8.31–8.56	Avoiding institutional care	9.86	9.60–10.12	Avoiding institutional care	9.39	9.16–9.62	Avoiding institutional care	8.61	8.41–8.81
12	Reduction of mortality	9.98	9.87–10.08	Reduction of mortality	10.23	9.99–10.48	Reduction of mortality	10.22	10.00–10.44	Reduction of mortality	9.75	9.55–9.95

CI, confidence interval.

groups indicated physicians' strong preference for this item. All the physician groups also considered "patient satisfaction," "maintaining a high level of activity," and "improvement of physical function" important after "improvement of quality of life," with some variation in the order of their preferences. Geriatricians ranked "effective treatment of illness" the third most important, in contrast to the other two physician groups that ranked this item lower. Adult day care staff ranked "improvement of quality of life" and "maintaining a high level of activity" first and second, respectively, but placed "reduction of carer burden" the third most important, unlike physicians.

With regard to the receiving side of health care, "effective treatment of illness," "improvement of physical function," and "reduction of carer burden" were given high priority, whereas "improvement of quality of life" tended to be perceived as less important.

All the groups, including both health care providers and recipients, ranked "reduction of mortality" the least important, followed by "avoiding institutional care," "improvement of social functioning," and "efficient use of resources," except for the adult day care staff who ranked "improvement of social functioning" higher than "effective treatment of illness."

Stratification analysis demonstrated that the results from physicians were not influenced by sex (male vs female, data not shown); however, physicians older than 60 years tended to rank "effective treatment of illness" and "improvement of physical function" higher compared with younger physicians, who appeared to prioritize "patient satisfaction" and "maintaining a high level of activity." Physicians with more than 30 years' experience, most of whom were older than 60 years, showed a similar tendency, prioritizing "effective treatment of illness" and "improvement of physical function." The results from adult day care staff were identical across groups stratified by age, years of experience, and qualification (data not shown).

The results from the health care recipients did not differ by nursing care level (relatively independent vs limited impairment or higher, or limited impairment vs needing extensive help or higher) for adult day care participants and patients in geriatric outpatient clinics, the existence of relatives who required nursing care (present vs absent) for patients in geriatric outpatient clinics, study site for patients in geriatric outpatient clinics and community-dwelling older adults, or sex for all health care recipient groups (data not shown). Although stratification by age showed that the three measures given highest priority were the same across the age groups (65 to 74 vs older than 75) in community-dwelling older adults, the younger group ranked "reduction of carer burden" first, whereas the older group ranked "effective treatment of illness" first (data not shown).

Discussion

This study is, to our knowledge, the largest survey ever conducted to describe health outcome prioritization in geriatric medicine. We aimed to obtain a comprehensive picture of the views of those involved in decision-making processes in geriatric medicine and compare views between health care providers and recipients. We chose four groups each from providers and recipients that are considered relevant to our purpose. The mean response rate was close to 50%, which was good for a large-scale postal survey and ensured the representative nature of our respondents.

This survey demonstrated that there may be an important gap in health outcome prioritization between health care providers and recipients in geriatric medicine. All health care provider groups, notably physicians, expressed a strong preference for improvement in quality of life (QOL) as a priority of care, whereas health care recipients gave the highest priority to effective treatment of diseases and tended to put lower importance on QOL. In the context of clinical medicine, QOL is often used as a nonspecific, all-encompassing term to describe

nonmortality outcomes averaged over multiple domains (ie, physical, social, and psychological functioning and well-being). Consideration of QOL is essential for the selection of a treatment option, particularly when conditions are noncurative and chronic.[15] Therefore, it is not surprising that physicians who regularly see older patients with multiple chronic conditions consider QOL the most important health care outcome. On the other hand, the term QOL may not be familiar to many health care recipients, and we cannot exclude the possibility that QOL might be confused with other terms, such as standard of living.

Most health care recipients ranked effective treatment of diseases as the most important, suggesting that patients are concerned about their own particular symptoms rather than nonspecific QOL, arguing for efforts to examine the symptoms most concerning to patients. The high importance of effective treatment of diseases ascribed by health care recipients, but not physicians, also implies the significance of the often-neglected aspect of inappropriate prescribing in older adults: underuse of medication likely to be beneficial to older adults. Increased evidence has suggested that failure to prescribe indicated, beneficial medication is common in older adults,[7,8,16] and recent attempts to provide an explicit list of appropriate, indicated medication for older adults are justified.[10]

Interestingly, views on patient satisfaction were also different. All physician groups ranked patient satisfaction as the second top priority, whereas health care recipients considered this to be less important. This tendency has been demonstrated in a prior small study in England more than 15 years ago.[12] Recently, patient satisfaction has been increasingly used to measure health care qualities and compare health plans or physicians.[17] However, our finding may argue against the value of patient satisfaction as a performance measure in geriatric medicine, especially in light of recent evidence suggesting that higher patient satisfaction is accomplished at the sacrifice of increased use of health care resources and may not be directly associated with technical quality of care or improved outcome.[17,18]

We observed agreement on several items between health care providers and recipients. The importance of physical and mental function, such as maintaining activity or improving physical function, was expressed by both health care providers and recipients. This finding was consistent with prior studies in older adults with multiple chronic conditions[12,19] or terminal conditions,[20,21] suggesting that physical and mental function should be an essential factor to consider as a health care outcome in various care settings for older patients.

Reduction in mortality was given the lowest priority by all the groups in health care providers and recipients alike. This view is similar to that observed in previous studies.[12,19] This finding supports the contention that treatment interventions should be assessed in terms of reduced morbidity and improved QOL in addition to reduced mortality.

In this survey, respondents' characteristics, except age, had limited influence on their views on health outcome prioritization within each group. Geriatricians older than 60 years and community-dwelling adults older than 75 years gave higher priority to effective treatment of diseases compared with their younger counterparts. This suggests that health outcome priorities may not be stable, and can change as respondents age or differ from generation to generation. The cross-sectional design of our survey prevented us from separating the age effect from the secular trend, and further studies will be required to examine the time- or setting-dependent variability of health outcome prioritization.

This study has several limitations. First, although the average response rate was high for a postal survey, it was lower in physician groups than in health care recipient groups (26% to 48% vs 44% to 61%, Table 1). Thus, selection bias cannot be excluded. Second, it was not sure that health care recipients, particularly adult day care participants, correctly understood the study terminology. Third, some of the items used in the survey were not mutually exclusive. Nevertheless, a similar trend in priorities of outcome measures according to either side of health care providers or recipients suggests that the overall results were not significantly affected by these limitations.

Conclusion

We demonstrated that there was significant agreement and disagreement of health outcome prioritization between health care providers and recipients in geriatric medicine. Health care providers and recipients agreed on high priority for function and low priority for reduction in mortality, but there was obvious disagreement in how they perceived QOL, treatment effect, and patient satisfaction as goals of care. Such disagreement necessitates better communication between providers and recipients to reach goals of care that are mutually understandable and tailored to meet patients' specific needs. The low importance of reduction in mortality and patient satisfaction ascribed by health care recipients may question the value of these outcomes as a way to assess treatment interventions and quality of care. We propose that the priorities of health care outcomes and their differences between providers and recipients demonstrated in this study should be taken into account in the health care of older patients and the design of health care policies and research.

Acknowledgments

We thank the following individuals for helping the acquisition and/or interpretation of data: Dr Yumi Kameyama, Dr Kiyoshi Yamaguchi, and Dr Sumito Ogawa, Department of Geriatric Medicine, Graduate School of Medicine, The University of Tokyo; Dr Katsuya Iijima, Institute of Gerontology, The University of Tokyo; Dr Yoichi Kosaka, Department of Geriatric Medicine, Tohoku University Graduate School of Medicine; Dr Hiroyuki Umegaki and Dr Yusuke Suzuki, Department of Geriatric Medicine, Nagoya University Graduate School of Medicine; and Dr Yukihiko Ikehata and Dr Ban Mihara, Japan Association of Medical and Care Facilities.

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Journal of Psychiatric Research 46 (2012) 1590–1594

Contents lists available at SciVerse ScienceDirect

Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/psychires

The high frequency of periodic limb movements in patients with Lewy body dementia

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ARTICLE INFO

Article history:
Received 12 January 2012
Received in revised form
5 July 2012
Accepted 9 July 2012

Keywords:
Periodic limb movements
Dementia with Lewy bodies
Alzheimer's disease
REM sleep behavior disorder
Polysomnographic recordings

ABSTRACT

Background: Although dementia with Lewy bodies (DLB) is the second most common form of neurodegenerative dementia after Alzheimer's disease (AD), the clinical diagnosis is frequently difficult. Because both REM sleep behavior disorders and Parkinson's disease also have alpha-synucleinopathy similar to DLB, and show an increase in periodic limb movements (PLM), we evaluated the association between DLB and PLM, which may serve as an additional information to differentiate AD and DLB.
Methods: Overnight polysomnographic recordings were performed for the inpatients in our hospital who were suspected to have dementia. The quality of sleep, oxygen-desaturation index and periodic limb movements were compared among the patients clinically diagnosed with DLB, AD or as having no dementia.
Results: Nine DLB patients, twelve AD patients and ten non-demented patients were enrolled in the study. The number of PLM during sleep per hour of total sleep time (PLMS index) was significantly higher in the DLB patients than the AD patients or the non-demented patients. No significant differences were found between the AD patients and the non-demented patients. To differentiate DLB from AD, a PLMS index of more than 15.0 had a sensitivity of 88.9% and a specificity of 83.3%.
Conclusions: The DLB patients exhibited a higher PLMS index than the AD patients, and this index could be clinically useful for the diagnostic differentiation of DLB from AD.

1. Introduction

Dementia with Lewy bodies (DLB) is the second most common form of neurodegenerative dementia after Alzheimer's disease (AD), affecting 15–25% of elderly demented patients (McKeith et al., 1996). DLB is characterized by intracytoplasmic inclusions called Lewy bodies, which consist of filamentous protein granules composed of alpha-synuclein and ubiquitin. Although the pathological diagnosis of DLB can be made based on the observation of Lewy body deposit throughout the cortex and subcortical regions, this is not generally possible except during autopsy.

The clinical diagnostic criteria for DLB were first published in 1996 (McKeith et al., 1996), and were modified in 2005 (McKeith et al., 2005). The central or core symptoms in DLB are progressive cognitive decline, recurrent visual hallucinations, spontaneous features of parkinsonism, and fluctuating cognition. These diagnostic criteria require a clinical evaluation by a trained neurologist and include few objective markers. Although Single Photon Emission Computed Tomography (SPECT) and ^{123}I-metaiodobenzylguanidine (MIBG) myocardial scintigraphy are useful in the differential diagnosis of DLB (Lobotesis et al., 2001; Colloby et al., 2002; Yoshita et al., 2001; Hanyu et al., 2006), these examinations are too expensive to be generally utilized.

DLB is frequently complicated with REM sleep behavior disorder (RBD) (McKeith et al., 2005; Boeve et al., 2001, 2003, 2007; Gagnon et al., 2006), which is characterized by an increase in periodic limb movements (PLM) (Fantini et al., 2002). Some reports have also indicated that there is an increase of PLM in patients with Parkinson's disease (PD) (Wetter et al., 2000; Lavault et al., 2009). In addition, both RBD and PD are alpha-synucleinopathies, similar to DLB.

The pathophysiology of PLM is not well understood. In addition to RBD and PD, some studies have also shown that advancing age is associated with PLM (Coleman et al., 1981; Ancoli-Israel et al., 1991). Furthermore, Rose et al. have suggested that there is an increase of PLM in severely demented patients (Rose et al., 2011).

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0022-3956/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jpsychires.2012.07.007

However, these hypotheses have not yet been systematically studied, and no controlled data have been published to date.

We hypothesized that the patients with DLB would exhibit a higher frequency of PLM compared to the demented patients with AD, and evaluated the usefulness of PLM measurement as a novel tool for the differential diagnosis of dementia. As a result, we observed that patients with DLB exhibited a significantly higher PLMS index compared to patients with AD.

2. Methods

2.1. Subjects

The study population was comprised of the consecutive inpatients of the Department of Geriatric Medicine at the University of Tokyo Hospital, who were admitted for the evaluation of progressive cognitive impairment. The patients underwent neuropsychological assessments, including the Mini-Mental State Examination (MMSE), Frontal Assessment Battery and Clock Draw Test. They also underwent blood tests and neuroimaging tests, such as Magnetic Resonance Imaging (MRI) and SPECT. The diagnosis was made at a consensus conference of physicians and neurologists, based on the clinical diagnostic criteria for DLB proposed by McKeith et al. in 2005 (McKeith et al., 2005), and the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's disease and Related Disorders Association (NINCDS-ADRDA) (McKhann et al., 1984). The patients with probable DLB and possible DLB were included in the DLB group. The non-demented group comprised the patients who did not fit the criteria for dementia in the medical and neurological examinations. Patients with cognitive impairments other than AD or DLB (e.g., normal pressure hydrocephalus, vascular dementia) were excluded from the study.

From November 2010 to September 2011, 43 patients were enrolled in this study. We excluded the 4 patients whose recorded total sleep time was less than two hours. In addition, we excluded five patients who were taking antipsychotics, antidepressants, levodopa, dopamine-agonists and clonazepam, for those drugs could have some effect on the PLM.

The study was approved by the institutional review board of the Graduate School of Medicine, University of Tokyo, and written informed consent was obtained from all participants before the study.

2.2. Polysomnography

The patients underwent overnight polysomnographic recordings in the inpatient ward. Thirty of the 31 patients underwent polysomnography at least three days after admission. The remaining patient, who was in the non-demented group, underwent polysomnography on an adaptation night. The recordings included two electroencephalogram (EEG) leads (C3–A2 and O2–A1), an electrooculogram (EOG) and submental electromyogram (EMG). Nasal and oral thermistor channels, arterial oxygen saturation (finger oximetry) and an EMG of both anterior tibialis muscles were also monitored (Somnotrac Pro, CareFusion, USA). All sleep recordings were scored visually by an experienced rater according to the standard criteria (Iber et al., 2007).

PLM were scored during sleep in accordance with international scoring rules (Zucconi et al., 2006). PLM were defined as four or more consecutive leg movements, which lasted 0.5–10 s, the interval of which was 5–90 s. Leg movements following apneas or hypopneas were excluded. Respiratory events were scored according to AASM guidelines (Iber et al., 2007). Sleep apneas were defined as complete cessation of airflow >10 s. Hypopneas were defined as a reduction ≥50% in airflow plus ≥3% drop in SpO_2 and/or a micro arousal. The apneas-hypopneas index (AHI) was calculated as the number of apneas and hypopneas per sleep hour. In some patients who removed the airflow sensor, oxygen desaturation of 3% or more was substituted to exclude the leg movements associated with breathing disorders and to calculate the AHI. Sleep efficiency, which was defined as the ratio of total sleep time to time in bed, was also calculated.

The number of PLM during sleep per hour of total sleep time (the PLMS index), the apneas-hypopneas index and the number of occasions of oxygen desaturation of 3% or more per hour of total sleep time (3%ODI) were calculated.

The patients who had REM sleep without atonia on polysomnography and had a history of harmful behaviors in sleep were diagnosed with RBD according to the diagnostic criteria (Iber et al., 2007).

2.3. Statistical analysis

The distribution of data was examined using the Shapiro–Wilk test. If data were normally distributed, a one way analysis of variance with Games-Howell post-hoc tests were applied for group comparisons. If the data deviated significantly from normality, the Kruskal–Wallis test was used, followed by evaluation with the Mann–Whitney U test for multiple comparisons, with the p values being corrected according to the Bonferroni method. The χ^2 test was used to compare categorical variables, such as gender and the number of RBD patients.

The diagnostic cutoff points for the PLMS index to discriminate between DLB and AD were estimated for each outcome by maximizing the Youden index. The discrimination ability was assessed by the area under the curve (AUC). Using this threshold, the sensitivity and specificity were calculated.

All of the statistical analyses were performed using the SPSS software program (version 19.0, SPSS inc., Chicago). Statistical significance was defined as p values < 0.05.

3. Results

3.1. Patients

Nine patients with DLB, twelve patients with AD and ten non-demented patients were enrolled in the study. Among the nine patients in the DLB group, five patients had probable DLB and four patients had possible DLB. The diagnoses in the four possible DLB patients were all supported by the typical findings in SPECT; generalized low uptake, reduced occipital activity, and relatively preserved hippocampal blood flow. In addition, three of the four possible DLB patients underwent MIBG myocardial scintigraphy and all showed low uptake. Table 1 shows the characteristics of the subjects. The age, sex distributions, and renal function were not significantly different among the three groups. No significant difference was found between the DLB group and the AD group ($p = 0.337$) in the MMSE. The use of medications for hypertension, hyperlipidemia and diabetes mellitus were similar between the groups. Two patients in the DLB group, two patients in the AD group and no patients in the non-demented group had taken donepezil. None of the patients fit the diagnostic criteria for restless legs syndrome (Allen et al., 2003).

3.2. Findings of polysomnography

The sleep and respiratory measurements are shown in Table 2. There were no significant differences in the percentage of Stage N3 or the percentage of REM sleep among the three groups. As

Table 1
Characteristics of DLB patients, AD patients and non-demented patients.

Characteristics	DLB patients	AD patients	Non-demented	*p* value
Number of subjects	$n = 9$	$n = 12$	$n = 10$	
Age (years)	82.9 ± 5.9	80.9 ± 6.2	79.1 ± 4.5	n.s.
Sex (men/women)	4/5	3/9	3/7	n.s.
MMSE	22.4 ± 3.5	20.3 ± 3.3	27.8 ± 2.1	<0.001*
Serum creatinine (mg/dl)	0.74 ± 0.27	0.74 ± 0.22	0.67 ± 0.15	n.s.
Hypertension	3 (33.3)	4 (25.0)	5 (50.0)	n.s.
Hyperlipidemia	1 (11.1)	1 (8.3)	1 (10.0)	n.s.
Diabetes mellitus	1 (11.1)	1 (8.3)	3 (30.0)	n.s.

Values expressed as mean ± standard deviation or number (%). * = one way analysis of variance with Games-Howell post-hoc tests: DLB vs AD $p = 0.337$, DLB vs non-demented $p = 0.005$, AD vs non-demented $p < 0.001$. AD = Alzheimer's disease; DLB = Dementia with Lewy bodies; MMSE = Mini-mental State Examination; n.s. = not significant.

expected, the prevalence of RBD was significantly higher in the DLB group compared to the AD group or the non-demented group ($p = 0.004$). The AHI and 3%ODI was slightly higher in the AD group compared to the DLB group and the non-demented group, but the difference was not statistically significant.

The observed PLMS indices are shown in Fig. 1. The patients in the DLB group had a significantly higher PLMS index compared to the patients in the AD group and those in the non-demented group. No significant differences in the PLMS index were found between the AD group and the non-demented group. The PLMS indices of the four DLB patients with RBD were 27.8, 147.8, 43.7 and 149.3, respectively. After the exclusion of these four DLB patients with RBD, there was also a statistically significant difference in the PLMS index between the patients with DLB and AD ($p = 0.025$). To discriminate DLB patients from AD patients using the PLMS index, the most favorable diagnostic threshold was found to be 8.0 (AUC = 0.926). This threshold had a sensitivity of 100% and a specificity of 75.0%. A PLMS index of more than 15.0 had a sensitivity of 88.9% and a specificity of 83.3%.

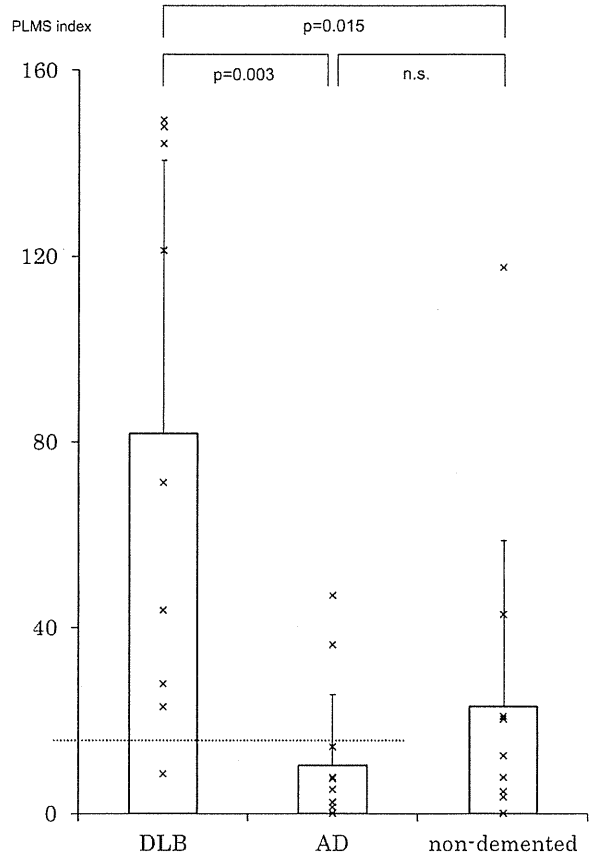

Fig. 1. Individual values for the periodic limb movements during sleep (PLMS) index in DLB patients, AD patients and non-demented patients. The boxes indicate mean and the vertical bars represent standard deviation; DLB = 81.8 ± 58.8, AD = 10.3 ± 15.3, non-demented = 23.0 ± 35.7. Mann–Whitney *U* test for multiple comparisons with the *p* values being corrected according to the Bonferroni method; significant differences in DLB vs AD ($p = 0.003$) and DLB vs Control ($p = 0.015$). The dashed line indicates the diagnostic threshold of the PLMS index of 15.0 between DLB and AD. This threshold had a sensitivity of 88.9% and a specificity of 83.3%. PLMS = periodic limb movements during sleep; AD = Alzheimer's disease; DLB = dementia with Lewy bodies; n.s. = not significant.

4. Discussion

In this study, we first observed that patients with DLB exhibited a significantly higher PLMS index compared to patients with AD.

Although the pathophysiology of PLM is not well understood, a decrease in dopaminergic activity is reported to be associated with PLM (Wetter et al., 2000; Desseilles et al., 2008; Staedt et al., 1995; Hening et al., 2004). Because abnormalities of the nigrostriatal dopaminergic pathway are also present in DLB patients, they would also be expected to exhibit a high frequency of PLM as a result of the decrease in dopaminergic activity (Walker et al., 2007; Walker and Walker, 2009).

We also found a high prevalence of RBD in patients with DLB, as indicated previously (McKeith et al., 2005; Boeve et al., 2001, 2003). RBD is now recognized to be a manifestation of various alpha-synucleinopathies, including DLB (Boeve et al., 2007; Claassen et al., 2010), and is also frequently complicated with an increase in PLM (Fantini et al., 2002; Manconi et al., 2007). These findings suggest the presence of strong pathophysiological associations among the DLB, PD, RBD and PLM through a common central nervous system degenerative process.

Several studies have showed an increase in the PLM frequency with advancing age (Coleman et al., 1981; Ancoli-Israel et al., 1991). Bliwise et al. reported a mean PLMS index during sleep of 20.6 in elderly individuals (Bilwise et al., 1988), which was compatible with our findings in the non-demented group. The clinical use of the PLMS index as a biomarker has not been anticipated, perhaps because of the high frequency of PLM in the elderly. However, our findings indicated that the PLMS index of the DLB patients was still higher than that of elderly patients without dementia, and

Table 2
Sleep measures and respiratory measures of DLB patients, AD patients and non-demented patients.

Polysomnography	DLB patients	AD patients	Non-demented	*p* value
Total sleep time (min)	283.3 ± 105.8	360.3 ± 89.1	341.8 ± 70.5	n.s.
Stage N1 (%TST)	40.6 ± 12.6	29.9 ± 13.4	29.6 ± 16.5	n.s.
Stage N2 (%TST)	41.0 ± 9.4	50.5 ± 9.5	47.8 ± 12.8	n.s.
Stage N3 (%TST)	3.6 ± 4.9	6.5 ± 4.8	7.4 ± 6.1	n.s.
REM (%TST)	14.8 ± 10.2	13.1 ± 7.8	15.3 ± 8.4	n.s.
Sleep efficiency (%)	75.5 ± 14.3	76.3 ± 8.6	76.5 ± 12.5	n.s.
Sleep onset latency (min)	25.9 ± 23.9	22.2 ± 25.8	21.8 ± 16.5	n.s.
Wake time (min)	96.8 ± 74.4	112.2 ± 44.1	104.1 ± 53.0	n.s.
AHI	11.1 ± 10.5	15.0 ± 12.8	13.8 ± 14.8	n.s.
3%ODI	11.0 ± 11.1	15.2 ± 14.6	13.4 ± 14.3	n.s.
RBD (No. of patients)	4	0	0	0.004*

Values expressed as (mean ± standard deviation). * = Significant differences with the χ^2 test ($p = 0.004$). AD = Alzheimer's disease; DLB = Dementia with Lewy bodies; TST = Total sleep time; REM = Rapid eye movement; AHI = apneas hypopneas index; ODI = oxygen desaturation index; RBD = REM sleep behavior disorder; n.s. = not significant.

furthermore, the distribution of the PLMS index was more clearly separated between the DLB patients and AD patients, likely because the non-specific variability of the PLM frequency would be overcome by the effects of predominantly progressing specific neurodegeneration in these patients.

In this study, we also compared the PLMS index between the AD group and non-demented group. No significant differences were found, but the PLMS index in the AD patients tended to be lower than that in the non-demented group. These findings might also be a characteristic feature of AD, otherwise it can not be ruled out whether the small sample size may account for a random bias with quite low PLMS indices in the AD group. Therefore, the relevance and phenomenology of PLMS especially in AD, but also in DLB has to be addressed in further studies.

Currently, DLB and AD are diagnosed according to their respective clinical diagnostic criteria (McKeith et al., 2005; McKhann et al., 1984), and their differentiation are frequently difficult. Our findings suggested the usefulness of the PLMS index to discriminate patients with DLB from those with AD. While the utilization of SPECT and MIBG myocardial scintigraphy are limited to well-equipped hospitals, simplified mobile device for the measurement of PLM (Sforza et al., 2005) is expected to perform the examination for more outpatients with dementia in clinical practice.

There are several limitations to the present study. First, we included the patients with possible DLB and probable DLB in the same DLB group. And we also did not make a pathological diagnosis of DLB or AD, which remains to be reported even in MIBG myocardial scintigraphy for the diagnosis of DLB. A prospective investigation on the course of the PLM index and cognitive impairment, including the eventual pathological diagnosis, should be examined in a future study. Second, the number of patients in each group was relatively small. However, our data indicate that there is a significant correlation between DLB and PLMS, and the data may provide a first hint for a difference between AD and DLB on the PLMS index. Third, the data for this study did not include objective or subjective measures of daytime sleepiness or day–night schedule. In the future study, an additional investigation involving a larger number of subjects should be performed.

In conclusion, we found that DLB patients exhibit a higher PLMS index than AD patients, and this index may be clinically useful in the diagnostic differentiation of DLB from AD.

Role of funding source

The funding source had no involvement in the study, design, analysis, interpretation or decision to submit this work.

Contributors

Shinichiro Hibi was involved in design, analysis, interpretation, and drafting of article. Yasuhiro Yamaguchi was responsible for conception, design, analysis, interpretation, and drafting of article. Yumi Umeda-Kameyama and Katsuya Iijima were involved in design. Toshimitsu Momose was involved in analysis. Hiroshi Yamamoto, Masahiro Akishita, and Yasuyoshi Ouchi were involved in design and interpretation. All authors had full access to the data and take responsibility for its integrity and the accuracy of the analysis.

Conflict of interest

All authors declare that they have no conflicts of interest.

Acknowledgment

This work was supported by grants-in-aid for young scientists and scientific research from the Ministry of Education, Science, Sports and Culture of Japan, and Research Grants from the Mitsui Sumitomo Insurance Welfare Foundation. We thank all participants.

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