The wave called delirium, from onset to consequences

Slor, C.J.

Publication date
2013

Chapter

6

Validation and psychometric properties of the delirium motor subtype scale in elderly hip fracture patients (Dutch version)

Chantal J. Slor
Dimitrios Adamis
René W.M.M. Jansen
David J. Meagher
Joost Witlox
Alexander P.J. Houdijk
Jos F.M. de Jonghe

Accepted for publication in *Archives of Gerontology and Geriatrics*

ABSTRACT

Background: Motor disturbances are common in delirium. Different methods have been used to identify motor subtypes of delirium, which possibly differ in pathophysiology, treatment needs and prognosis. The Delirium Motor Subtype Scale (DMSS) was developed to capture all the previous different approaches to subtyping into one new instrument and emphasize disturbances of motor activity rather than associated psychomotoric symptoms.

Methods: We investigated the reliability and validity of the DMSS Dutch version. Elderly patients who had undergone hip fracture surgery received the Dutch version of the DMSS and the Delirium Rating Scale revised 98. A diagnosis of delirium was defined according to the Confusion Assessment Method.

Results: Among 146 patients, 46 (32%) patients were diagnosed with delirium (mean age 86.3 years SD 5.2). The internal consistency of the DMSS was acceptable (Cronbach's alpha=0.72). If an item was removed at random the internal consistency of the scale remained the same. Similarly the concurrent validity of DMSS was good (Cohen's kappa=0.73) while for each motor subtype the Cohen's kappa ranged from 0.58 to 0.85. The sensitivity and specificity of DMSS to detect each subtype ranged from 0.56 to 1 and from 0.88 to 0.98 respectively.

Conclusion: This study suggests that the Dutch version of the Delirium Motor Subtype Scale is a reliable and valid instrument. Assessments on each patient were generally performed by the same rater, although this could imply correlation between the ratings, the DMSS and DRS-R-98 items are different. Second, the decided cut-off scores for the DRS-R-98 might have had some influence on the results. Despite these limitations, the translated scale can differentiate different motor subtypes within an elderly hip-fracture patient sample. The DMSS has scientific validity that could allow for greater precision in further research on motor subtypes.

INTRODUCTION

Delirium is a complex neuropsychiatric syndrome that is common in hip surgery patients and is associated with long-term negative outcomes that include cognitive deterioration, institutionalization and mortality.[1] It is characterized by acute onset, fluctuation in consciousness and inattention, along with a range of neuropsychiatric and cognitive symptoms.

Disturbances in motor activity are almost invariably present in full syndromal illness and follow two principal patterns involving hyperactivity and hypoactivity.[2,3] These features can present as a variety of clinical subtypes, hyperactive, hypoactive, and mixed subtype, where elements of both hyperactivity and hypoactivity occur within short time frames.[4] Studies suggest that these subtypes may have important differences in pathophysiology, treatment needs and prognosis.[5] In addition, a key difference is that hypoactive presentations are more frequently not recognised and/or misdiagnosed in clinical practice.[6] However, results remain inconsistent since other studies have found poorer prognosis for the hyperactive or mixed subtype.[7,8] These inconsistencies are related to differences in clinical populations studied, but are also impacted upon by the use of different methods for defining clinical subtypes.[3] Motor subtypes of delirium have been identified with symptom checklists,[9,10] motor items from delirium severity rating scales[7,11,12] or based on clinical impression.[13] The DRS-R-98 has been translated into the Dutch language and can be used to distinguish delirium motor subtypes.[12] All these previous subtyping methods have included psychobehavorial disturbances supposedly associated with motor activity levels, such as changes to affect, sleep, or psychotic symptoms. To capture all these different elements and approaches within a single 30-item instrument The Delirium Motoric Checklist was developed.[3] This instrument combined features from three psychomotor subtyping schemas.[9,10,14] Subsequently this was reduced to an 11-item Delirium Motor Subtype Scale (DMSS) based upon relative specificity of items for delirium vs. non-delirious controls and also according to correlation of items with independently assessed motor activity as per items 7 and 8 of the DRS-R-98.[3,15] This new tool emphasises disturbances of motor activity rather than associated psychomotoric symptoms in motor subtyping.[5] It is a simple instrument, designed for both medical and non-medical staff and suggested to have good concurrent and predictive validity.[16,17] Also, DMSS-defined motor subtypes (hypoactive, hyperactive, mixed and no subtype) have been shown to match electronic measure of motion, although the principal differences were between hyperactive and hypoactive patients, and less significant differences regarding the mixed motor profile were found.[18] The DMSS can allow for more precise diagnosis of clinical subtypes of delirium, which in turn can allow more focused research of delirium pathophysiology and treatment.[15] While initial studies of the DMSS validity are promising, studies have been limited to palliative care settings, and validity needs to be established in other patient samples, including elderly hip fracture patients.

Few studies have examined motor subtypes of delirium in hip surgery patients.[7,19-21] These have used a variety of methods to identify motor subtypes including the Memorial Delirium Assessment Scale (MDAS), the classification system developed by Liptzin and Levkoff and the criteria as described by Lipowski.[4,9,22] Some of these studies in hip fracture patients found no differences between motor subtypes, while others did find significant associations.

The aim of the present study was to report on the reliability and validity of the Delirium Motor Subtype Scale Dutch version in a sample of hospitalized elderly hip-fracture patients with delirium. To the best of our knowledge it is the first time delirium subtypes after hip surgery were examined in great detail using the DMSS.

METHODS

Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki and the guidelines on Good Clinical Practice. Approval of the regional research ethics committee was obtained. All patients gave written informed consent.

Study design and objectives

The study was conducted in a series of consecutively admitted elderly hip fracture patients to a teaching hospital in Alkmaar, the Netherlands (Clinicialtrials.gov; registration number NCT00497978; Research on delirium has been published previously[23]).

Patients were ineligible to participate in the study if they had no surgery, had a malignancy, had a previous hip-fracture on the identical side, were in contact isolation, incapable of participating in interviews (language barrier, aphasia, coma), had no acute trauma or received a total hip prosthesis.

Baseline (preoperative) assessment

The baseline assessment was completed within 12 hours of admission and before surgery. It consisted of patient and proxy interviews, assessment of delirium, and inspection of all available medical records. Demographic variables such as age and gender were also documented. Assessments were performed by trained and experienced members of the research team.

A diagnosis of delirium was defined according to the criteria of the Confusion Assessment Method (CAM) which consists of an acute onset and fluctuating course of cognitive function, inattention, and either disorganized thinking and/or altered level of consciousness.[24] The CAM algorithm was rated on the basis of an interview with the patient and hospital staff, brief cognitive assessment with the MMSE and the expanded digit span test, and screening of the medical and nursing records for signs of delirium.[25,26] During hospital admission presence of delirium was assessed daily from time of admission until

the fifth postoperative day or discharge. In identified cases of delirium assessments were conducted until remission for three consecutive days (CAM negative) or until discharge.

Translation of the DMSS

The DMSS was translated into Dutch by two members of the research staff experienced in delirium research. The translators were native Dutch speakers, both fluent in English. Back-translation was done by native English speakers, also fluent in Dutch. The final translation was approved by David Meagher, one of the developers of the original DMSS.

Delirium motor subtype definition

Delirium was classified into hypoactive, hyperactive, mixed and no motor subtype according to two methods (1) the DMSS, and (2) using the motor items of the DRS-R-98.[15,27] The DMSS and Delirium Rating Scale Revised-98 (DRS-R-98) were assessed daily.

The Delirium Motor Subtype Scale (DMSS) is a scale using 11 motor items derived from items used in previous motor subtyping methods but with relative specificity for delirium.[15] It can be rated by any healthcare professional who is familiar with patient behaviour and can be used to rate the previous 24 hours or more. Each symptom is rated as absent (score 0) or present (score 1). DMSS hyperactive subtype was deemed present if there was definite evidence in the previous 24 hours (and this should be a deviation from pre-delirious baseline) of at least two of the following symptoms (items 1-4): increased quantity of motor activity, loss of control of activity, restlessness and wandering. Hypoactive subtype was deemed present if there was definite evidence in the previous 24 hours (and this should be a deviation from pre-delirious baseline) of two or more of the following symptoms (items 5-11): decreased amount of activity, decreased speed of actions, reduced awareness of surroundings, decreased amount of speech, decreased speed of speech, listlessness and reduced alertness/withdrawal. At least one of either decreased amount of activity or speed of actions must be present. Mixed Motor Subtype was present if there was evidence of both hyperactive and hypoactive subtype criteria in the previous 24 hours. If there was evidence of neither hyperactive or hypoactive subtype in the previous 24 hours this was classified as no motor subtype.

As a comparison DRS-R-98 defined motor subtypes were used. For subtype classification with the Delirium Rating Scale Revised-98 (DRS-R-98) items 7 (motor agitation) and 8 (motor retardation) were used.[27] Hypoactive delirium is defined as a score of 1-3 on DRS-R-98 item 8 (motor retardation) and a score of 0 on DRS-R-98 item 7 (motor agitation). Hyperactive delirium is defined as a score of 1-3 on DRS-R-98 item 7 and a score of 0 on DRS-R-98 item 8. The mixed subtype is defined as scores of 1-3 on both DRS-R-98 item 7 and 8. The no motor subtype had scores of 0 on both items.

Statistical Analysis

Statistical analyses were conducted using SPSS version 20.

The following analyses were performed with the sample of delirious patients. Cronbach's alpha was used to estimate the internal consistency of the DMSS. To estimate the concurrent validity of the groups of the four motor subtypes, as defined by the DMSS. The motor subtypes were compared with the motor subtypes as defined by the DRS-R-98 items 7 (motor agitation) and 8 (motor retardation), using the Cohen's kappa statistic. To graphically represent the relationships between each one of the DMSS motor categories with the comparable motor category, as it has been defined by the DRS-R-98, a correspondence analysis was used. Correspondence analysis is a graphical technique to represent the rows and columns of a two way (in this case the DMSS and DRS-R-98 motor categories) contingency table in a joint plot.

RESULTS

146 patients were included of which 46 (31.5%) patients were diagnosed with delirium on the first postoperative day. Analyses were performed with data on this first postoperative day to minimise loss of data due to attrition and to include more delirious participants, since this day had the highest delirium frequency.

Descriptive statistics

The mean age of the 46 patients was 86.3 years (SD: 5.2, range 73-97). The sample consisted of 29 (63%) female patients. The number of delirious participants within each delirium motor subtype according to the DMSS and the DRS-R-98 ratings are shown in Table 1. Of the 100 non-delirious patients, 7% was categorized as hypoactive, 6% was hyperactive, none were mixed and 87% was classified as no motor subtype according to the DMSS. The same non-delirious sample was classified with the DRS-R-98 into 15% hypoactive, 17% hyperactive, 3% mixed and 65% no motor subtype.

Reliability analysis

The internal consistency of the scale was assessed with the Cronbach's alpha. The Cronbach's alpha for the 11 items in the sample of delirious participants (n=46) was 0.72.

As the scale itself consists of two different parts no split-half method was used. However, if an item was removed at random the internal consistency of the scale remained the same. This is an indication that the scale can be reduced to a smaller number of items.

Because the measured target (motor activity) can change from one day to another no test-retest reliability analysis was performed.

Table 1. Number of Delirious Patients within each Motor Subtype based on DMSS and DRS-R-98.

	DMSS Motor Subtypes				
	Hypoactive Subtype	**Hyperactive Subtype**	**Mixed Subtype**	**No Motor Subtype**	**Total**
DRS-R-98 Motor Subtypes					
Hypoactive Subtype	n=11	n=0	n=1	n=1	n=13
Hyperactive Subtype	n=0	n=14	n=0	n=0	n=14
Mixed Subtype	n=4	n=3	n=9	n=0	n=16
No Motor Subtype	n=0	n=0	n=0	n=3	n=3
Total	n=15	n=17	n=10	n=4	n=46

DMSS is Delirium Motor Subtype Scale.
DRS-R-98 is Delirium Rating Scale Revised-98.

Concurrent Validity

The psychometric properties of the DMSS were evaluated in the group of delirious participants (n=46). Overall Cohen's kappa was 0.73 and Cramer's V was 0.78. The agreement between the DMSS and DRS-R-98 on motor subtype categorization, and the sensitivity and specificity, for the delirious group are shown in Table 2.

Table 2. Agreement, Sensitivity and Specificity of the Scale in the Delirium Sample (n=46).

	Kappa value	**Sensitivity (CI)**	**Specificity (CI)**
Hypoactive Subtype	0.69	0.84 (CI: 0.54 – 0.97)	0.88 (CI: 0.71 – 0.96)
Hyperactive subtype	0.85	1 (CI: 0.73 – 1)	0.90 (CI: 0.74 – 0.97)
Mixed Subtype	0.58	0.56 (CI: 0.31 – 0.80)	0.97 (CI: 0.80 – 1)
No Motor Subtype	0.85	1 (CI: 0.31 – 1)	0.98 (CI: 0.86 – 1)

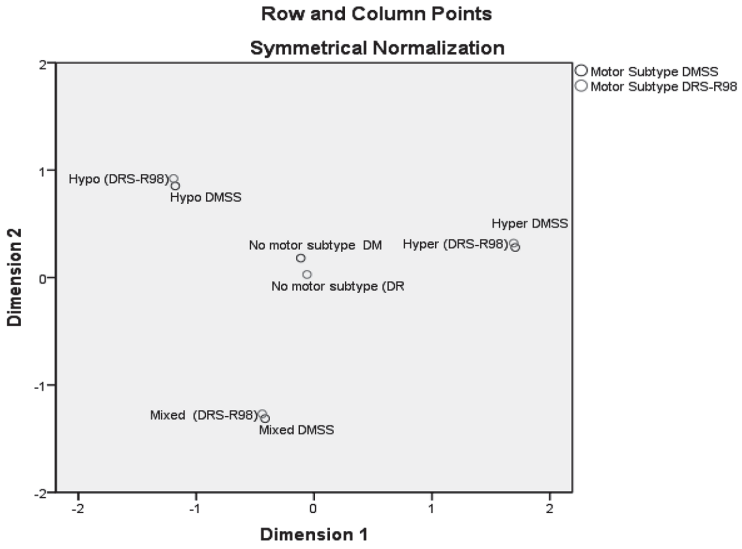
CI=Confidence Interval

Correspondence analysis

A two dimensions solution explained the relationship between the categories of each scale (cumulative proportion of inertia 95%) best. Figure 1 shows the relations between the categories (motor subtypes) of each scale. Points that are close together are more

similar than points that are far apart. From the graph it can be seen that both scales identify the four subtypes very well.

Figure 1. Correspondence Analysis – Relationship between DMSS and the DRS-R-98 defined Motor Subtype Categories.



DISCUSSION

This study examined validity and psychometric properties of the Dutch version of the Delirium Motor Subtype Scale in a sample of hospitalized elderly hip-fracture patients with and without delirium. We found that the translated scale had acceptable psychometric properties. The Dutch DMSS had good agreement with the DRS-R-98 on motor subtype identification, which confirms the findings in the initial study on the DMSS.[15] However, in contrast to the DRS-R-98 method of subtype attribution, the DMSS had greater specificity for delirium as evidenced by the substantially lower attribution of motor subtypes in non-delirious patients.

The DRS-R-98 was used as a reference measure of motor activity in this study. The Dutch version of the DRS-R-98 has been found to distinguish hypoactive and non-hypoactive subtypes.[12] Although uncertainty remains about optimal cut-off scores and the DMSS is relatively more precise regarding the particular aspects of motor activity that can define subtypes and is also designed for use by a range of healthcare staff, rather than those with delirium-expertise as recommended for the DRS-R-98. Further research can be

supported by the use of more 'objective' measures of motor activity, such as actigraphy / electronic motion analysis. Studies of delirious patients indicate that different motor activity patterns can be distinguished by this means.[18,28-30] However, it remains unclear whether the three motor subtypes represent distinct categories, since less significant differences have been found for the mixed subtype.[18] Further research with both these 'objective' measures of motor activity and motor ratings and categorization like the DMSS can advance our knowledge on this subject.

Delirium was originally classified into two motor subtypes, i.e. hyperactive and hypoactive.[31] A third category, mixed, was subsequently added in recognition that elements of both subtypes can appear within short time frames.[4] The status of mixed motor subtype has been uncertain. Previous work with palliative care patients indicated that this subtype was common, associated with more severe overall delirium and stable over time in a large percentage of patients.[2] This supports mixed motor subtype as a separate motor category, and not just a reflection of the fluctuating nature of delirium or a transitional phase between hypoactive and hyperactive subtypes. However, this study highlights that there is much lower concordance between the DMSS and DRS-R-98 methods regarding the attribution of mixed rather than other clinical subtypes and suggests that its delineation may require further revision informed by studies in other clinical populations and using electronic motion analysis. The '*no motor subtype*', without substantial motor activity disturbances present, is suggested to reflect less severe, subsyndromal or even questionable delirium.[2] This is in keeping with the method by which the DMSS items were selected i.e. according to relative specificity of motor symptoms for delirium vs. non-delirious controls. Of note, more than 90% of delirious patients met criteria for either hypoactive, hyperactive or mixed motor subtypes whilst in contrast 87% of non-delirious patients were deemed 'no subtype' emphasising the relative specificity of the motor activity items in the DMSS for delirium. The relative homogeneity of the hip surgery sample in our study made it very suitable to study motor subtypes without the potential confounding effects of different underlying somatic illnesses.

Longitudinal research might also increase our understanding of the existence of different motor subtype categories. Since most studies are cross-sectional there is limited knowledge regarding the stability of motor subtypes over the course of delirium. Recent work with palliative care patients indicated that the mixed subtype is common and stable throughout the delirium episode in almost two-thirds of the patients who present with mixed profile on the first assessment.[2] Further research in different populations can explore the stability of motor subtypes over time, using instruments such as the DMSS for subtype categorization.

A limitation of this study is that the assessments on each patient were generally performed by the same rater. This might challenge the validity, because the ideal would be independent assessments. Although this could imply correlation between the ratings,

the DMSS and DRS-R-98 items are different. Thus the good agreement between both scales on subtype identification found in this study supports the validity of the Dutch version of the DMSS. Since there is no overall agreement on optimal cut-off scores for the DRS-R-98 when used for motor subtyping, the decided cut-off scores might have had some influence on the results. A cut-off score of 2 might have increased the specificity for the mixed subtype, but would reduce the coverage of delirium with many patients falling in to the no subtype category.

In conclusion, the findings in this study suggest that the translated version of the DMSS is a valid and reliable instrument. It can differentiate different motor subtypes within an elderly hip-fracture patient sample. The DMSS has scientific validity that could allow for greater precision in studies exploring important issues such as detection, pathophysiology, treatment and prognosis of motor subtypes. Further use of this instrument, including studies with longitudinal design, can advance our knowledge on the different delirium motor subtypes.

REFERENCES

1. Witlox J, Eurelings LS, de Jonghe JF, Kalisvaart KJ, Eikelenboom P, van Gool WA. Delirium in elderly patients and the risk of postdischarge mortality, institutionalization, and dementia: a meta-analysis. *Journal of the American Medical Association* 2010; 304:443-451.
2. Meagher DJ, Leonard M, Donnelly S, Conroy M, Adamis D, Trzepacz PT. A longitudinal study of motor subtypes in delirium: frequency and stability during episodes. *Journal of Psychosomatic Research* 2012; 72:236-241.
3. Meagher DJ et al. Motor symptoms in 100 patients with delirium versus control subjects: comparison of subtyping methods. *Psychosomatics* 2008; 49:300-308.
4. Lipowski ZJ. Delirium in the elderly patient. *New England Journal of Medicine* 1989; 320:578-582.
5. Meagher D. Motor subtypes of delirium: past, present and future. *International Review of Psychiatry* 2009; 21:59-73.
6. Meagher D, Leonard M. The active management of delirium: Improving detection and treatment. *Advances in Psychiatric Treatments* 2008; 14:292-301.
7. Marcantonio E, Ta T, Duthie E, Resnick NM. Delirium severity and psychomotor types: their relationship with outcomes after hip fracture repair. *Journal of the American Geriatrics Society* 2002; 50:850-857.
8. Kobayashi K, Takeuchi O, Suzuki M, Yamaguchi N. A retrospective study of delirium subtype. *Japanese Journal of Psychiatry and Neurology* 1992; 46:911-917.
9. Liptzin B, Levkoff SE. An empirical study of delirium subtypes. *British Journal of Psychiatry* 1991; 161:843-845.
10. O'Keeffe ST, Lavan JN. Clinical significance of delirium subtypes in older people. *Age and Ageing* 1999; 28:115-119.
11. Platt MM, Breitbart W, Smith M, Marotta, R, Weisman H, Jacobsen PB. Efficacy of neuroleptics for hypoactive delirium. *Journal of Neuropsychiatry and Clinical Neurosciences* 1994; 6:66.
12. de Rooij SE, van Munster BC, Korevaar JC, Casteelen G, Schuurmans MJ, van der Mast RC, Levi M. Delirium subtype identification and the validation of the Delirium Rating Scale--Revised-98 (Dutch version) in hospitalized elderly patients. *International Journal of Geriatric Psychiatry* 2006; 21:876-882.
13. Van der Cammen TJM, Tiemeier H, Engelhart MJ, Fekked D. Abnormal neurotransmitter metabolite levels in Alzheimer patients with a delirium. *International Journal of Geriatric Psychiatry* 2006; 21:838-843.
14. Lipowski ZJ. (1980). Delirium: Acute Brain Failure in Man. New York, Oxford University Press.
15. Meagher D et al. A new data-based motor subtype schema for delirium. *Journal of Neuropsychiatry and Clinical Neurosciences* 2008; 20:185-193.
16. Leonard M et al. Motion analysis in delirium: a novel method of clarifying motoric subtypes. *Neurocase* 2007; 13:272-277.
17. Meagher D, Leonard M, Donnelly S, Conroy M, Adamis D, Trzepacz PT. A Longitudinal Study of Motor Subtypes in Delirium: Relationship with Other Phenomenology, Etiology, Medication Exposure and Prognosis. *Journal of Psychosomatic Research* 2011; 71:395-403.
18. Godfrey A, Leonard M, Donnelly S, Conroy M, O'Laighin G, Meagher D. Validating a new clinical subtyping scheme for delirium with electronic motion analysis. *Psychiatry Research* 2010; 178:186-190.
19. Santana-Santos F, Wahlund LO, Varli F, Tadeu Velasco I, Eriksdottier Jonhagen M. Incidence, clinical features and subtypes of delirium in elderly patients treated for hip fractures. *Dementia and Geriatric Cognitive Disorders* 2005; 20:231-237.
20. Van Munster, BC, Korevaar JC, de Rooij SE, Levi M, Zwinderman AH. The association between delirium and the apolipoprotein E epsilon 4 allele in the elderly. *Psychiatric Genetics* 2007; 17:261-266.

21. Van Munster BC, Korevaar JC, Zwinderman AH, Levi M, Wiersinga WJ, de Rooij SE. Time course of cytokines during delirium in elderly patients with hip fractures. *Journal of the American Geriatrics Society* 2008; 56:1704-1709.

22. Breibart W, Rosenfeld B, Roth A, Smith MJ, Cohen K, Passik S. The Memorial Delirium Assessment Scale. *Journal of Pain and Symptom Management* 1997; 13:128-137.

23. Witlox J et al. Cerebrospinal fluid β-amyloid and tau are not associated with risk of delirium: a prospective cohort study in older adults with hip fracture. *Journal of the American Geriatrics Society* 2011; 59:1260-1267.

24. Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. *Annals of Internal Medicine* 1990; 113:941-948.

25. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research* 1975; 12:189-198.

26. Lindeboom J, Matto D. Digit series and Knox cubes as concentration tests for elderly subjects. *Tijdschrift voor Gerontologie en Geriatrie* 1994; 25:63-68.

27. Trzepacz PT, Mittal D, Torres R, Kanary K, Norton J, Jimerson N. Validation of the Delirium Rating Scale-revised-98: comparison with the delirium rating scale and the cognitive test for delirium. *Journal of Neuropsychiatry and Clinical Neurosciences* 2001; 13:229-242.

28. Van Uitert M, de Jonghe A, de Gijsel S, van Someren EJ, de Rooij SE, van Munster BC. Rest-activity patterns in patients with delirium. *Rejuvenation Research* 2011; 14:483-490.

29. Osse RJ, Tulen JH, Bogers AJ, Hengeveld MW. Disturbed circadian motor activity patterns in postcardiotomy delirium. *Psychiatry and Clinical Neurosciences* 2009; 63:56-64.

30. Honma H et al. Motor activity rhythm in dementia with delirium. *Psychiatry and Clinical Neurosciences* 1998; 52:196-198.

31. Lipowski ZJ. Transient cognitive disorder in the elderly. *American Journal of Psychiatry* 1983; 140:1426-1436.