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Restless Legs Syndrome Risk Factors, Behaviors, and Diagnoses in Persons With Early to Moderate Dementia and Sleep Disturbance

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Abstract

In this study, restless legs syndrome (RLS) risk factors, RLS-associated behaviors, and the ability to understand and answer an RLS diagnostic interview were investigated. In 23 older adults with early to moderate dementia and nighttime sleep disturbance, the most common risk factors for RLS were a periodic leg movement sleep index > 15 (54.55%), based on polysomnography, and use of selective serotonin reuptake inhibitors (SSRIs) (34.78%). The most common RLS-associated behaviors were repetitious mannerisms (56.52%) and general restlessness (34.78%), according to direct observation from research assistants. Finally, older adults with early to moderate dementia were unable to understand and reliably answer the RLS diagnostic interview. Older persons with mild to moderate dementia and sleep disturbance may require objective diagnostics to identify RLS.

Older adults who have dementia and severe nighttime sleep disturbance experience impaired daytime functioning and may become institutionalized (Blackwell, Yaffe, Schneider, Ancoli-Israel, & Stone, 2004; Bliwise, 2000; Haimov et al., 2004; Hatfield, Herbert, Van Someren, Hodges, & Hastings, 2004). One potential cause for their nighttime sleep disturbance is restless legs syndrome (RLS), which is common, yet frequently undiagnosed. It is estimated that between 9% and 24% of older adults are affected by RLS (Lavigne & Montplaisir, 1994; Mosko et al., 1988; Nichols et al., 2003; Ohayon & Roth, 2002; Rothdach, Trenkwalder, Habersack, Keil, & Berger, 2000) that is associated with significantly decreased health status (Phillips et al., 2000; Rothdach et al., 2000), cognitive functioning (Allen & Earley, 2001), and quality of life (Abetz et al., 2004; Abetz, Arbuckle, Allen, Mavraki, & Kirsch, 2005). Uncontrolled RLS also can lead to falls that result in multiple fractures (Kuzniar & Silber, 2007).

This study (supported by Veterans Affairs NRI 01-077-1) involved 23 participants with early to moderate dementia (Ashford, Schmitt, & Kumar, 1998) and nighttime sleep disturbance. We sought to determine if these participants had risk factors for RLS, RLS-associated behaviors, and if they could answer the RLS diagnostic interview.

Of note, risk factors for RLS in older adults include certain medications, such as selective serotonin reuptake inhibitors (SSRIs); selective norepinephrine reuptake inhibitors (SNRIs) (Bliwise, 2006; Yang, White, & Winkelman, 2005); and certain diseases and conditions such as arthritis, rheumatoid arthritis, peripheral neuropathy, diabetes, hypothyroidism, renal failure or insufficiency, and iron deficiency (Allen et al., 2003; Brown, Dedrick, Doggett, & Guido, 2005; Garcia-Borreguero, Odin, & Schwarz, 2004; O'Keeffe, Gavin, & Lavan, 1994; Phillips, Hening, Britz, & Mannino, 2006; Reynolds, Blake, Pall, & Williams, 1986; Salih, Gray, Mills, & Wesley, 1994; Silber & Richardson, 2003; Sun, Chen, Ho, Earley, & Allen, 1998). In addition, a periodic leg movement sleep index of > 15 , although not essential for a diagnosis, may be associated with RLS where, for example, one study showed this occurrence in more than 80% of persons with RLS (Montplaisir et al., 1997).

RLS-associated behaviors are also important indicators in older adults with dementia and may present as wandering and restlessness, particularly in the evening (Bliwise, 2006). Proposed criteria for RLS diagnosis in the elderly with dementia can be recognized as the following:

1. Signs of leg discomfort, such as rubbing or kneading the legs, and groaning while holding the lower extremities.
2. Excessive motor activity in the lower extremities, such as pacing.
3. Signs of leg discomfort that is exclusively present or worsen during rest or inactivity.
4. Signs of leg discomfort diminished with activity.
5. Criteria 1 and 2 occur only in the evening or worsen in the evening or night (Allen et al. 2003).

More important, diagnosis of RLS is typically based on the gold standard of self-reported symptoms, rather than objective observation, and symptoms that are routinely gathered from a diagnostic patient interview (Allen et al., 2003). Although adults with mild dementia may be able to answer simple questions regarding RLS symptoms (Chibnall & Tait, 2001), the RLS interview may not be either sensitive or specific in the elderly patient with dementia. Underdiagnosis and poor differential diagnosis in this population warrant close attention to both risk factors for RLS and RLS-related behaviors, neither of which necessitate self-reporting of symptoms.

METHOD

Participants

The sample consisted of older adults who lived in private homes, had dementia, and were participating in an observational study describing sleep and behavioral disturbances (supported by Veterans Affairs NRI 01-077-1). The specific aims of the observational study were to (a) describe the polysomnographically recorded nighttime sleep and behavioral symptoms of persons with dementia and caregiver-reported nighttime behavioral symptoms and (b) determine if total sleep time, probable RLS, apnea-hypopnea index, oxygen saturation nadir, or periodic leg movement sleep index predict observed nighttime behavioral symptoms in persons with dementia and caregiver-reported nighttime behavioral symptoms.

Inclusion criteria were (a) possible or probable Alzheimer's disease or other dementias; (b) age 2: 60 years; (c) living with an English-speaking caregiver (spouse, adult child, friend, or sibling); (d) a caregiver report of one or more nighttime sleep or behavior problems (e.g., waking up too early in the morning, difficulty falling asleep, awakenings associated with behavioral symptoms such as wandering); (e) ambulatory; and (f) medically stable, defined as unchanged medications within 30 days and absence of flu-like symptoms, fever, or other symptoms of acute illness. We excluded persons who had a prior diagnosis of and current treatment for RLS or obstructive sleep apnea syndrome.

This secondary analysis includes 23 of the first 57 consented participants in the observational study. Of the 19 persons excluded from the observational study, 6 refused, 7 had missing data, 3 did not meet inclusion criteria, staff withdrew two, and one withdrew. Fifteen participants who scored below 18 on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) were excluded because we assumed that persons with lower cognitive status could not adequately complete the RLS interview.

Procedures

We recruited participants from a National Institute on Aging Alzheimer's Disease Center, from geriatric clinics at a Veterans Health Care System and a University hospital, and local Alzheimer's disease support groups. The Human Research Advisory Committee at the responsible institution approved the cross-sectional descriptive analysis reported here. Obtaining informed consent from participants and their legal authorized representatives preceded collection of demographic data including age, sex, race, marital status, former occupation, usual bedtime and arousal time, resuscitation orders, and relationship of the caregiver to the participants.

A registered nurse conducted the MMSE at participants' homes, usually in the early afternoon. In addition, the nurse, trained by a board-certified sleep specialist (Kathy Richards), conducted the RLS diagnostic interview (Allen et al., 2003). Based on essential RLS criteria developed at the National Institutes of Health (NIH) RLS diagnosis and epidemiology workshop (Allen et al., 2003), the nurse asked participants four questions:

1. Do you ever have feelings like creeping, crawling, tingling, or pain in your legs that make you want to move your legs or walk?
2. Do these happen when you are still?
3. Does moving improve them?
4. Are these symptoms worse in the evening or at night?

For each question, participants answered "yes" or "no," and the nurse probed to make a differential diagnosis. For example, the nurse asked participants to describe their leg symptoms, the conditions that brought on the symptoms, the kind of movement that helped relieve them, and when the symptoms started and ended in the evening or night. The nurse waited 15 to 30 min and repeated the interview.

A medical records review involved the nurse recording the RLS risk factors of

1. Medication use, including antidepressant and dopamine antagonists.
2. Diseases-specifically, arthritis, rheumatoid arthritis, peripheral neuropathy, diabetes, hypothyroidism, and renal failure or insufficiency.
3. Iron deficiency.

Polysomnography (PSG) provided descriptive information on sleep characteristics of the sample and assessed an additional RLS risk factor: a periodic leg movement sleep index > 15. At the convenience of the participants and their caregivers, 2 nights of PSG preceded 3 nights of observation in the participants' homes. Although performing PSG in the more controlled environment of the sleep laboratory would have prevented the need for the technician to travel to participants' homes, the advantages outweighed the disadvantages. Studying participants in the unfamiliar environment of the sleep laboratory would have disrupted their daily routines and sleep patterns and, thus, potentially affected the quality of data. Further, transportation of the participant to the sleep laboratory for at least 2 nights would have precluded participation for some persons.

Trained sleep technicians, blind to the participants' demographic information, MMSE scores, RLS risk factors, and diagnostic interview results, conducted 2 nights of attended PSG using standardized methodology. A technician stayed the entire night to keep participants from entangling themselves in the monitoring devices and to ensure devices were running properly.

The technician arrived at the participant's home 1 to 2 hr prior to bedtime to meet the participant and caregiver, explain procedures, and set up equipment. The technician encouraged participants and caregivers to ask questions and continue their normal activities before bedtime.

During the recording sessions, the PSG equipment, video monitor, and technician remained outside the participant's room—a procedure that, in previous studies, proved less confusing to participants who awakened and also provided a more typical picture of their sleep. The technician taped connecting cables to the sides of the room to protect participants from tripping over them. A small portable video camera was placed inside the participant's room, which transmitted images to a monitor outside and allowed the technician to continuously observe the participant to assure safety and the integrity of the equipment.

The technician did not attempt to confine the participant to bed, unless necessary to avoid danger. If the participant wanted to get up, the technician disconnected the electrodes from the connecting cable, continued to record, and described these episodes as awake, with reconnection of the participant to equipment upon returning to bed.

If the participant became agitated and intentionally or accidentally removed the monitoring devices, the technician attempted to reattach them. If the participant resisted, the technician left the room and tried again after 30 min. If this strategy failed, the technician terminated PSG, and another night was scheduled.

The technician collected PSG data with the Grass Portable Polysomnography Data Acquisitions System (Astro-Med, Inc., West Warwick, RI) and followed standard manufacturer's guidelines. The technician used three electroencephalogram leads (C3-A2, C4-A1, and O2-A1), right and left electrooculograms, and submental is electromyogram. Other measurement recordings were abdominal respiratory movements with two strain gauges, oral and nasal airflow through a thermistor, snore vibrations with a microphone taped slightly to the right of the hyoid thoracic, and finger pulse oximetry with a Palco 340 (Palco Laboratory, Inc., Santa Cruz, CA) or Non 8600 (Nonin Medical Inc., Minneapolis, MN). A standard lead 2 electrocardiogram was recorded, as well as attached surface electromyogram electrodes, placed 3 cm to 4 cm apart on the right and left anterior tibialis muscles to record leg movements. The technician stopped PSG when participants woke up in the morning or after 10 hr.

A registered polysomnographic technologist with extensive experience and training in scoring sleep stages in neurodegenerative disease evaluated the sleep studies. She was blind to the participants' demographic information, risk factors, MMSE scores, and RLS diagnostic interview results.

The technologist collapsed non-rapid eye movement (NREM) sleep categories into indeterminate NREM sleep and excluded the criterion of muscle atonia in rapid eye movement (REM) sleep (Bliwise, Williams, Irbe, Ansari, & Rye, 2000). The inter-scorer reliability between the technologist and a board-certified sleep specialist (Donald L. Bliwise) was 89.4% initially and 90% at 6 months.

The technologist scored apneas with standardized criteria, defined as use of 90-sec to 120-sec frames with rechecked event scoring using 30-sec epochs. Obstructive sleep apnea was defined as complete or almost complete cessation (25% of the amplitude at baseline) of airflow for at least 10 sec, accompanied by chest or abdominal wall movement (Lee-Chiang, 2002). Hypopneas were scored if a reduction in airflow occurred for 2: 10 sec, regardless of whether oxygen desaturation or an arousal followed. We chose this scoring approach for three reasons:

1. Central nervous system arousals are more difficult to score in persons with neurodegenerative disease because of the common diffuse slowing of the electroencephalogram in this population.
2. To avoid "overscoring" periodic leg movements caused by hypopneas, since movements frequently follow hypopneas and can mimic periodic leg movements.
3. Although the nasal-oral thermistor is not sensitive in detecting flow limitations, persons with dementia tolerate the thermistor better than the nasal pressure transducer.

To score periodic leg movements, the technologist used the following definition: repeated movements of the extremities occurring during sleep with an inter-movement interval between 5 sec and 90 sec in a sequence of four or more with duration of movements from 0.5 sec to 5 sec (Coleman, 1982). The technologist omitted movements that followed snores or subtle reductions in airflow. She calculated the periodic leg movement sleep index by dividing the number of leg movements by the total hours of sleep. In addition, a board-certified sleep specialist (Kathy Richards) reviewed all studies.

Within 1 week after PSG, research assistants, who were blind to the participants' demographic information, MMSE scores, RLS risk factors and diagnostic interview results, and PSG evaluations, conducted 3 nights of direct observation at each participant's home. Before data collection, a co-investigator with expertise in behavioral observation instructed assistants in the theory of behavioral observation. She described principles of structured behavioral observations, such as the observer as an instrument and the importance of accuracy and interrater reliability. During the training, two research assistants watched videotapes of older adults with disruptive behaviors, discussed and practiced categorization of these behaviors with the investigator (Kathy Richards), and, subsequently and independently, categorized disruptive behaviors from a videotape using the Cohen-Mansfield Agitation Inventory (CMAI; Cohen-Mansfield, Marx, & Rosenthal, 1989). Interrater reliability between the gold standard rater (Kathy Richards) and the two research assistants was .89. Interrater reliability between the research assistants was .94.

The assistant obtained RLS-associated behaviors using the CMAI from 7 p.m. to 12 midnight on Night 1 and from 10 p.m. to 6 a.m. on Nights 2 and 3 in participants' homes.

We included one early evening observation time because some persons with dementia display more RLS-associated behaviors in the early evening (i.e., "sundowning").

The assistant made observations while the participant was out of bed. On the 2 nights of scheduled observations between 10 p.m. and 6 a.m., the assistant set up the video camera in the participant's room and a monitor outside of the room. If the participant wandered from the room where the camera was located, the assistant directly observed him or her, intervening only if the behavior posed a clear threat. This technique was necessary to observe disruptive behaviors outside the bedroom. The assistant entered the observational data every 5 min. The total number of observational hours, allowing for assistant breaks, was 19 per participant.

Measures

MMSE—This 30-item standardized screen measures orientation, registration, short-term memory, attention and concentration, language, and constructional capacity items. Scores range from 0 to 30, with higher numbers indicating better cognitive functioning (Folstein, Folstein & McHugh, 1975; Tombaugh & McIntyre, 1992). Previous studies found that test-retest reliability (24 hr) was .83 (Folstein et al., 1975; Tombaugh & McIntyre, 1992), and validity with similar measures ranged from .66 to .88 (Anthony, LeResche, Niaz, von Korff, & Folstein, 1982; Foreman, 1987). Sensitivity and specificity to detect mild to moderate dementia using a cut-point score of 26 were 98% and 100%, respectively (van Gorp et al., 1999).

Categorization of RLS risk factors—We categorized participants by the number of risk factors they had on a 3-point scale ranging from 0 (0 to 1 risk factor), 1 (2 to 3 risk factors), to 2 (4 risk factors).

RLS-associated behaviors—The CMAI is a retrospective, 29-item behavior rating scale designed for use in nursing homes (Cohen-Mansfield et al., 1989). A modified version that changed each statement from past to present tense on the CMAI for direct observational research attained an interrater reliability of .74 for late afternoon-evening observations in 22 nursing home residents (Chrisman, Tabar, Whall, & Booth, 1991) and .93 to .95 in 31 nursing home residents (Whall et al., 1999). Convergent validity with the Ward Behavior Inventory exceeded .80 (Whall et al., 1999).

The CMAI consists of three factors: aggressive behavior (such as hitting, kicking, pushing, or scratching), verbally agitated behavior (such as complaining, constant requests for attention, and negativism), and physically non-aggressive behavior (PNAB; such as pacing, inappropriate robing or disrobing, and general restlessness) (Cohen-Mansfield et al., 1989). This secondary analysis concentrates on items within the factor of PNAB (Cohen-Mansfield et al., 1989). The specific items associated with RLS behaviors (Bliwise, 2006) are pacing (wandering), trying to get to a different place, general restlessness (fidgeting or moving around when in a seat or repeatedly getting up and sitting down), and repetitious mannerisms (rocking or rubbing) (Cohen-Mansfield, 1991).

RESULTS

The sample consisted of 15 men and 8 women residing in private homes, with a mean age of 79.78 ± 6.49 (range= 70–96). They were either married ($n = 17$) or widowed ($n = 6$). Their MMSE (Anthony et al., 1982; Foreman, 1987) scores ranged from 18 to 29 ($M = 24.00 \pm 3.29$). Specifically, 1 participant scored 18, indicating moderate dementia; 8 scored between 19 and 23, indicating mild dementia; and 14 scored 24, indicating early dementia (Ashford et al., 1998).

Eighteen (75%) had a diagnosis of Alzheimer's disease, whereas 5 were diagnosed with unspecified dementia. All participants were taking either a cholinesterase inhibitor or memantine, and 7 participants were taking both. Most were taking donepezil ($n = 13$), followed by memantine ($n = 9$), galantamine ($n = 5$), and rivastigmine ($n = 3$).

Participants' previous diagnoses of sleep disorders were obstructive sleep apnea ($n = 3$) and insomnia ($n = 1$). Three were taking medications for sleep-specifically, trazodone ($n = 2$) and zolpidem ($n = 1$), a sedative hypnotic. Participants also were taking medications that may relieve RLS symptoms. Specifically, 2 were taking an iron supplement, and 2 were taking one opioid each.

The sample's total sleep time was 308.34 min (SD = 110.63; range = 51.50–468.00) while the mean time in bed was 483.02 min (SD = 82.85; range = 258.50–601.00). The mean sleep efficiency was 62.65% (SD = 18.33%; range = 20%–87%). The sleep apnea-hypopnea index was 20.36 (SD = 18.59; range = 2.00–71.50).

Risk Factors for RLS

Based on data from 22 participants, 12 participants (54.55%) had a periodic leg movement sleep index > 15. We report the sleep characteristics and periodic leg movement sleep index score from both nights, with the periodic leg movement sleep index > 15 risk factor determined specifically using the data from the night when the participants had the highest periodic leg movement sleep index.

The mean periodic leg movement sleep index was 15.36 (SD = 4.39) on Night 1, and the periodic leg movement sleep index without arousals was 11.42 (SD = 3.72). Variability in the indexes were compared for both nights, using a paired t test, and differences were observed for sleep parameters. There were no significant differences between Night 1 and Night 2 in periodic leg movement sleep indexes or sleep parameters (see Table 1 for periodic leg movement sleep index variability data for Nights 1 and 2). Technical difficulties prevented us from gathering data on periodic leg movement sleep from 1 participant.

Proportions of the sample with additional RLS risk factors included SSRI use ($n = 8$; 34.78%), osteoarthritis or degenerative joint disease ($n = 6$; 26.09%), diabetes ($n = 8$; 34.78%), hypothyroidism ($n = 3$; 13.04%), dopamine antagonist use ($n = 3$; 13.04%), SNRI use ($n = 2$; 8.70%), renal failure or insufficiency ($n = 1$; 4.35%), and peripheral neuropathy ($n = 1$; 4.35%). No participant had rheumatoid arthritis or iron deficiency anemia. The periodic leg movement sleep index > 15 risk factor was not significantly related to SSRI use (two-sided $p = 1.00$, for Fisher's exact test), but was related to osteoarthritis or degenerative joint disease (two-sided $p = .015$, for Fisher's exact test) and diabetes (two-sided $p = .002$, for Fisher's exact test).

The mean number of risk factors for RLS among participants was 1.91 ± 1.04 and ranged from zero to four. Specifically, 8 (34.78%) had zero to one risk factor, 14 (60.87%) had two to three risk factors, and 1 (4.35%) had four risk factors.

RLS-Associated Behaviors

All but one participant displayed a disruptive behavior on the CMAI during the evening or night-a time when RLS behaviors are most likely to occur. The total mean score was 18.55 (SD = 15.76) and ranged from 0 to 62. The mean score on the PNAB factor was 5.45 (SD = 6.10) and ranged from 0 to 22. Within the PNAB factor, the number and percentage of participants displaying RLS-associated behaviors from highest to lowest was as follows: repetitious mannerisms ($n = 13$; 56.52%), general restlessness ($n = 8$; 34.78%), pacing (wandering; $n = 4$; 17.39%), and trying to get to a different place ($n = 2$; 8.70%).

RLS Diagnostic Interview

Participants had little difficulty answering the first diagnostic question, "Do you ever have feelings like creeping, crawling, tingling, or pain in your legs that make you want to move your legs or walk?" However, they did not seem to remember if the feelings occurred while they were staying still (Question 2), if moving improved them (Question 3), or if the symptoms worsened in the evening or at night (Question 4). Six participants (MMSE: $M = 22.67 \pm 2.94$; range = 18–25 [moderate to early dementia]) changed their answers to the questions after 15 to 30 min. Specifically, MMSE scores were 18 ($n = 1$), 20 ($n = 1$), 24 ($n = 2$), and 25 ($n = 2$), respectively. Therefore, the MMSE was not able to differentiate between those participants who were able and unable to understand the questions. Although 17 participants (MMSE: $M = 24.47 \pm 3.36$; range = 19–29 [mild to early dementia]) did not change their answers, they were unable to describe or remember their symptoms in sufficient detail on the probe questions for the nurse to make a differential diagnosis, which could include painful neuropathy, arthritic conditions (involving lower limbs), neuroleptic-induced akathisia, non-specific pacing or sleep disturbance associated with dementia, pruritus, leg cramps, vascular insufficiency, anxiety disorder, and agitated depression (Allen et al., 2003).

DISCUSSION

We recognize that the periodic leg movement sleep index does not signify any definitive diagnosis of RLS. However, we consider this secondary analysis in terms of hypothetical alternatives it underscores for sensitive and specific objective RLS measures and implications for further research. Research on the incidence and prevalence of periodic limb movement sleep disorder in older adults with dementia remains scarce (Boeve, Silber, & Ferman, 2002), but a recent study reported that 78% of participants with dementia had a periodic leg movement sleep index > 21 based on caregiver responses to the periodic leg movement subscale of the Sleep Disorders Questionnaire (McCurry, Gibbons, Logsdon, Vitiello, & Teri, 2005).

The percentage of participants with a periodic leg movement sleep index > 15 was 54.55%, and the sample's mean periodic leg movement sleep index score was 23.52. In this study, we found a nonsignificant trend of only a slightly higher periodic leg movement sleep index on Night 2. One night of sleep recording is, therefore, sufficient for assessment of the periodic leg movement sleep index parameter in persons with dementia. Others have shown that, although inter-night variability may occur regardless of age, severity, or disease duration, the periodic leg movement sleep index and nocturnal pattern of occurrence are highly consistent across nights in patients with RLS (Sforza & Haba-Rubio, 2005). The periodic leg movement sleep index > 15 risk factor was significantly related to osteoarthritis or degenerative joint disease and diabetes, but not to SSRI use. However, the number of participants who had the risk factors was small.

The second highest risk factor for RLS was SSRI use (34.78%), which is shown to increase to 43.48% when combining an SSRI with an SNRI. Other studies of persons with dementia reported that 23% (Aalten, de Vugt, Jaspers, Jolles, & Verhey, 2005) and 24% (Craig, Mirakhur, Hart, McIlroy, & Passmore, 2005) were treated with antidepressants. A population-based cross-sectional study found that 32% of persons with dementia had depression (Lyketsos et al., 2002). In a 2-year investigation of persons with dementia, 35.2% had depression at baseline, and 24.1% had it after 2 years (Aalten et al., 2005). Another study reported that 54% of persons with dementia had depression during the course of their dementia (Craig et al., 2005). In residential care-assisted living and nursing home residents with dementia, 25% of patients were depressed (Gruber-Baldini et al., 2005). Thus,

depression and SSRI use occurs in a substantial proportion of persons with dementia and is a risk factor for RLS.

Although no participant in this study had an anemia diagnosis, it should be noted that older adults with dementia may become iron deficient if they forget to eat or have trouble preparing nutritionally adequate meals, which may necessitate iron replacement therapy (Boeve et al., 2002). Raising the ferritin level above 50 ug/l reduces RLS symptoms (Boeve et al., 2002). The study did not directly measure iron deficiency.

The sample had low percentages of general restlessness, pacing and wandering, or trying to get to another place. Yet, a higher percentage of repetitious mannerisms (rocking or rubbing) was found than other studies (Tractenberg et al., 2001), indicating the high occurrence of RLS-associated behaviors.

We know of no other study that has attempted to diagnose RLS in persons with dementia using a diagnostic interview. We found that even participants with mild and early dementia did not possess sufficient cognitive and communication skills to provide the information needed for a trained registered nurse to diagnose RLS. The subjective RLS diagnostic interview is designed for persons who can recall and report their complex RLS symptoms. Early signs of dementia include language and word-finding limitations (Atkinson & Reilly, 1995). Even persons without cognitive impairment sometimes have difficulty finding the appropriate words to describe their RLS symptoms (Allen et al., 2003).

In the future, a comprehensive diagnostic strategy is needed to assess RLS in persons with dementia and may require a combination of methods. A need also exists to evaluate the utility of the methods and approach in the overall sleep assessment. In this study, the video camera placed in the participant's room allowed the technician to observe the participant continuously and assured the participants' safety, as well as integrity of the equipment. Videotaping in the home may provide a practical benefit to study participants and a hypothetical benefit in terms of accurately recording natural sleep and behavioral conditions. The development of other observational measures to assess for RLS include behavioral indicators, as discussed, the use of actigraphy for monitoring of periodic leg activity, and serum ferritin measurements, since iron deficiency may indicate RLS. The NIH RLS workshop suggested testing the validity of behavioral indicators to diagnose RLS in older adults with dementia (Allen et al., 2003). Objective measures of RLS have not been validated, have been demonstrated as impractical for use in older adults with dementia, or were tested with selected samples (Allen, 2005; Bliwise, Carskadon, & Dement, 1988; Gorny, Allen, Krausman, & Shah, 2000; Michaud, Paquet, Lavigne, Desautels, & Montplaisir, 2002; Montplaisir et al., 1997; Shochat, Oksenberg, Hadas, Molotsky, & Lavie, 2003). This lack of sensitive and specific objective RLS diagnostic measures impedes research and treatment of RLS in older adults with dementia.

The NIH RLS workshop also suggested taking a detailed history from caregivers and family members to make an accurate diagnosis of probable RLS in older adults with dementia (Allen et al., 2003). Histories of older adults with dementia obtained from caregivers and families have been valuable for assessing psychological well-being (Burgener, Twigg, & Popovich, 2005), the personality traits of extraversion or introversion (Kolanowski & Richards, 2002), everyday functioning (Davis, Martin-Cook, Hynan, & Weiner, 2006), neuropsychiatric disorders (Steffens, Maytan, Helms, & Plassman, 2005), and depression (Mayer et al., 2007).

Summary

Participants had RLS risk factors-particularly, periodic leg movement sleep index > 15 and SSRI use-as well as RLS-associated behaviors, predominantly repetitious mannerisms, and general restlessness. It was not possible to determine with certainty whether these older adults with early to moderate dementia understood the questions on the RLS diagnostic interview. Specifically, the MMSE did not differentiate between participants who could and could not answer the questions, indicating the need for more sensitive measures to determine who can accurately self-report their symptoms. The consequences of untreated RLS include disturbed sleep, which is a common problem in older adults with dementia and often results in falls, reduced quality of life, and institutionalization (Blackwell et al., 2004; Bliwise, 2000; Haimov et al., 2004; Hatfield et al., 2004). These facts underscore the necessity of a multi-pronged approach to RLS diagnosis in this population of persons with dementia and sleep disturbance, where accurate RLS diagnosis and differential diagnosis depend on more than self-report.

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REFERENCES

- Aalten P, de Vugt ME, Jaspers N, Jolles J, Verhey FRJ. The course of neuropsychiatric symptoms in dementia. Part I: Findings from the two-year longitudinal Maasbed study. *International Journal of Geriatric Psychiatry*. 2005; 20:523–530. [PubMed: 15920712]
- Abetz L, Allen RP, Pollet A, Washburn T, Early CJ, Kirsch J, et al. Evaluating the quality of life of patients with restless legs syndrome. *Clinical Therapeutics: The International Peer-Reviewed Journal of Drug Therapy*. 2004; 26:925–935.
- Abetz L, Arbuttle R, Allen RP, Mavradi E, Kirsch J. The reliability, validity and responsiveness of the Restless Legs Syndrome Quality of Life questionnaire (RLSQoL) in a trial population. *Health and Quality of Life Outcomes*. 2005; 3:19. [PubMed: 15790407]
- Allen RP. Is one night enough for measurement of periodic limb movements in sleep of restless legs patients? *Sleep*. 2005; 28:296–297. [PubMed: 16173647]
- Allen RP, Earley CJ. Restless legs syndrome: A review of clinical and pathophysiologic features. *Journal of Clinical Neurophysiology*. 2001; 18:128–147. [PubMed: 11435804]
- Allen RP, Picchietti D, Hening WA, Trenkwalder C, Walters AS, Montplaisir J. Restless legs syndrome: diagnostic criteria, special considerations, and epidemiology. *Sleep Medicine*. 2003; 4:101–119. [PubMed: 14592341]
- Anthony JC, LeResche L, Niaz U, von Korff MR, Folstein MF. Limits of the "Mini-Mental State" as a screening test for dementia and delirium among hospital patients. *Psychological Medicine*. 1982; 12:397–408. [PubMed: 7100362]
- Ashford, JW.; Schmitt, F.; Kumar, V. Diagnosis of Alzheimer's disease. In: Kumar, V.; Eisdorfer, C., editors. *Advances in the diagnosis and treatment of Alzheimer's disease*. New York: Springer; 1998. p. 111-151.
- Atkinson G, Reilly T. Effects of age and time of day on preferred work rates during prolonged exercise. *Chronobiology International*. 1995; 12:121–134. [PubMed: 8653798]
- Blackwell T, Yaffe K, Schneider J, Ancoli-Israel S, Stone K. The association of actigraphy measures of sleep and cognitive impairment in elderly women: The SOF study [Abstract]. *Sleep*. 2004; 27:A127.

- Bliwise, D. Dementia. In: Kryger, MH.; Roth, T.; Dement, WC., editors. Principles and practice of sleep medicine. 3rd ed.. Philadelphia: Saunders; 2000. p. 1058-1071.
- Bliwise D. Periodic leg movements in sleep and restless legs syndrome: Considerations in geriatrics. *Sleep Medicine Clinics*. 2006; 1:263–271. [PubMed: 19881897]
- Bliwise D, Carskadon MA, Dement WC. Nightly variation of periodic leg movements in sleep in middle aged and elderly individuals. *Archives of Gerontology & Geriatrics*. 1988; 7:273–279. [PubMed: 3228331]
- Bliwise D, Williams M, Irbe D, Ansari F, Rye D. Inter-rater reliability for identification of REM sleep in Parkinson's disease. *Sleep*. 2000; 23:671–678. [PubMed: 10947035]
- Boeve B, Silber M, Ferman T. Current management of sleep disturbances in dementia. *Current Neurology and Neuroscience Reports*. 2002; 2:169–177. 2002. [PubMed: 11898484]
- Brown LK, Dedrick DL, Doggett JW, Guido PS. Antidepressant medication use and restless legs syndrome in patients presenting with insomnia. *Sleep Medicine*. 2005; 6:443–450. [PubMed: 16084763]
- Burgener SC, Twigg P, Popovich A. Measuring psychological well-being in cognitively impaired persons. *Dementia*. 2005; 4:463–486.
- Chibnall JT, Tait RC. Pain assessment in cognitively impaired and unimpaired older adults: A comparison of four scales. *Pain*. 2001; 92:173–186. [PubMed: 11323138]
- Chrisman M, Tabar D, Whall AL, Booth DE. Agitated behavior in the cognitively impaired elderly. *Journal of Gerontological Nursing*. 1991; 17:9–13. [PubMed: 1761822]
- Cohen-Mansfield, J. Instruction manual for the Cohen-Mansfield Agitation Inventory (CMAJ). Rockville, MD: Research Institute of the Hebrew Home of Greater Washington; 1991.
- Cohen-Mansfield J, Marx MS, Rosenthal AS. A description of agitation in a nursing home. *Journal of Gerontology*. 1989; 44:M77–M84. [PubMed: 2715584]
- Coleman, RM. Periodic movements in sleep (nocturnal myoclonus) and restless legs syndrome. In: Guilleminault, C., editor. *Sleeping and waking disorders: Indications and techniques*. Menlo Park, CA: Addison Wesley; 1982. p. 265-295.
- Craig D, Mirakhor A, Hart DJ, Mcilroy SP, Passmore AP. A cross-sectional study of neuropsychiatric symptoms in 435 patients with Alzheimer's disease. *American Journal of Geriatric Psychiatry*. 2005; 13:460–468. [PubMed: 15956265]
- Davis BA, Martin-Cook K, Hynan LS, Weiner MF. Caregivers' perceptions of dementia patients' functional ability. *American Journal of Alzheimer's Disease and Other Dementias*. 2006; 21:85–91.
- 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; 12:188–198.
- Foreman MD. Reliability and validity of mental status questionnaires in elderly hospitalized patients ... the SPMSQ, MMSE, and CCSE. *Nursing Research*. 1987; 36:216–220. [PubMed: 3299279]
- Garcia-Borreguero D, Odin P, Schwarz C. Review article: Restless legs syndrome: An overview of the current understanding and management. *Acta Neurologica Scandinavica*. 2004; 109:308–317.
- Gorny SW, Allen RP, Krausman DT, Shah R. Accuracy of two ambulatory devices for automated detection of restless leg activity [Abstract]. *Sleep*. 2000; 23(Suppl. 2):A387.
- Gruber-Baldini AL, Zimmerman S, Boustani M, Watson LC, Williams CS, Reed PS. Characteristics associated with depression in long-term care residents with dementia. *Gerontologist*. 2005; 45:50–55. [PubMed: 16230749]
- Haimov I, Hanuka E, Spira T, Hadad B, Shefer O, Breznitz N, et al. Sleep and cognitive functioning in elderly people with and without insomnia. *Sleep*. 2004; 27:A125.
- Hatfield CF, Herbert J, Van Someren EJ, Hodges JR, Hastings MH. Disrupted daily activity/rest cycles in relation to daily cortisol rhythms of home-dwelling patients with early Alzheimer's dementia. *Brain*. 2004; 127:1061–1074. [PubMed: 14998915]
- Kolanowski A, Richards KC. Introverts and extraverts: Leisure activity behavior in persons with dementia. *Activities, Adaptation, and Aging*. 2002; 26:1–16.
- Kuzniar TJ, Silber MH. Multiple skeletal injuries resulting from uncontrolled restless legs syndrome. *Journal of Clinical Sleep Medicine*. 2007; 3:60–61. [PubMed: 17557456]

- Lavigne GJ, Montplaisir JY. Restless legs syndrome and sleep bruxism: Prevalence and association among Canadians. *Sleep*. 1994; 17:739–743. [PubMed: 7701186]
- Lee-Chiang, TL. Monitoring respiration during sleep. In: Lee-Chiang, TL.; Sateia, MJ.; Carskadon, MA., editors. *Sleep medicine*. Philadelphia: Hanley & Belfus, Inc; 2002. p. 639–646.
- Lyketsos CG, Lopez O, Jones B, Fitzpatrick AL, Breitner J, DeKosky S. Prevalence of neuropsychiatric symptoms in dementia and mild cognitive impairment. *Journal of the American Medical Association*. 2002; 288:1475–1483. [PubMed: 12243634]
- Mayer LS, Bay RC, Politis A, Steinberg M, Steele C, Baker AS, et al. Comparison of three rating scales as outcome measures for treatment trials of depression in Alzheimer's disease: Findings from DIADS. *International Journal of Geriatric Psychiatry*. 2007; 21:930–936. [PubMed: 16955427]
- McCurry SM, Gibbons LE, Logsdon RG, Vitiello MV, Teri L. Nighttime insomnia treatment and education for Alzheimer's disease: A randomized, controlled trial. *Journal of the American Geriatrics Society*. 2005; 53:793–802. [PubMed: 15877554]
- Michaud M, Paquet J, Lavigne G, Desautels A, Montplaisir J. Sleep laboratory diagnosis of restless legs syndrome. *European Neurology*. 2002; 48:108–113. [PubMed: 12187001]
- Montplaisir J, Boucher S, Poirier G, Lavigne G, Lapierre O, Lesperance P. Clinical, polysomnographic, and genetic characteristics of restless legs syndrome: A study of 133 patients diagnosed with new standard criteria. *Movement Disorders*. 1997; 12:61–65. [PubMed: 8990055]
- Mosko SS, Dickel MJ, Paul T, LaTour T, Dhillon S, Ghanim A, et al. Sleep apnea and sleep-related periodic leg movements in community resident seniors. *Journal of the American Geriatrics Society*. 1988; 36:502–508. [PubMed: 3372929]
- Nichols DA, Allen RP, Grauke JH, Brown JB, Rice ML, Hyde PR, et al. Restless legs syndrome symptoms in primary care: A prevalence study. *Archives of Internal Medicine*. 2003; 163:2323–2329. [PubMed: 14581252]
- Ohayon MM, Roth T. Prevalence of restless legs syndrome and periodic limb movement disorder in the general population. *Journal of Psychosomatic Research*. 2002; 53:547–554. [PubMed: 12127170]
- O'Keeffe ST, Gavin K, Lavan JN. Iron status and restless legs syndrome in the elderly. *Age & Ageing*. 1994; 23:200–203. [PubMed: 8085504]
- Phillips B, Hening W, Britz P, Mannino D. Prevalence and correlates of restless legs syndrome: Results from the 2005 National Sleep Foundation poll. *Chest*. 2006; 129:76–80. [PubMed: 16424415]
- Phillips B, Young T, Finn L, Asher K, Hening WA, Purvis C. Epidemiology of restless legs symptoms in adults. *Archives of Internal Medicine*. 2000; 160:2137–2141. [PubMed: 10904456]
- Reynolds G, Blake DR, Pall HS, Williams A. Restless leg syndrome and rheumatoid arthritis. *British Medical Journal*. 1986; 292:659–660. [PubMed: 3081215]
- Rothdach AJ, Trenkwalder C, Haberstock J, Keil U, Berger K. Prevalence and risk factors of RLS in an elderly population: The MEMO Study. *Neurology*. 2000; 54:1064–1068. [PubMed: 10720275]
- Salih AM, Gray RES, Mills KR, Webley M. A clinical serological and neurophysiological study of restless legs syndrome in rheumatoid arthritis. *British Journal of Rheumatology*. 1994; 33:60–63. [PubMed: 8162461]
- Sforza E, Haba-Rubio J. Night-to-night variability in periodic leg movements in patients with restless legs syndrome. *Sleep Medicine*. 2005; 6:259–267. [PubMed: 15854857]
- Shochat T, Oksenberg A, Hadas N, Molotsky A, Lavie P. The KickStrip: A novel testing device for periodic limb movement disorder. *Sleep*. 2003; 26:480–483. [PubMed: 12841376]
- Silber MH, Richardson JW. Multiple blood donations associated with iron deficiency in patients with restless legs syndrome. *Mayo Clinic Proceedings*. 2003; 78:52–54. [PubMed: 12528877]
- Steffens DC, Maytan M, Helms MJ, Plassman BL. Prevalence and clinical correlates of neuropsychiatric symptoms in dementia. *American Journal of Alzheimer's Disease and Other Dementias*. 2005; 20:367–373.
- Sun ER, Chen CA, Ho G, Earley CJ, Allen RP. Iron and the restless legs syndrome. *Sleep*. 1998; 21:371–377. [PubMed: 9646381]
- Tombaugh TN, McIntyre NJ. The Mini-Mental State Examination: A comprehensive review. *Journal of the American Geriatrics Society*. 1992; 40:922–935. [PubMed: 1512391]

- Tractenberg RE, Gamst A, Weiner MF, Koss E, Thomas RG, Teri L, et al. Frequency of behavioral symptoms characterizes agitation in Alzheimer's disease. *International Journal of Geriatric Psychiatry*. 2001; 16:886–891. [PubMed: 11571769]
- van Gorp WG, Marcotte TD, Sultzer D, Hinkin C, Mahler M, Cummings JL. Screening for dementia: Comparison of three commonly used instruments. *Journal of Clinical & Experimental Neuropsychology*. 1999; 21:29–38. [PubMed: 10420999]
- Whall AL, Black MEA, Yankou DJ, Groh CJ, Kupferschmid BJ, Foster NL, et al. Nurse aides' identification of onset and level of agitation in late stage dementia patients. *American Journal of Alzheimer's Disease*. 1999; 14:202–206.
- Yang C, White DP, Winkelman JW. Antidepressants and periodic leg movements of sleep. *Biological Psychiatry*. 2005; 58:510–514. [PubMed: 16005440]

TABLE 1
 Variability in Polysomnography Periodic Leg Movement Sleep Index Data Between Nights 1 and 2

<i>Variable</i>	<i>Night 1 (n=22)</i>		<i>Night 2 (n=22)</i>		<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
PLMSI	15.36	4.39	20.71	4.78	-.123
PLMSI with arousals	3.25	1.18	5.92	1.82	-.121
PLMSI without arousals	11.42	3.72	14.14	3.43	-.283
PLMSI with awakenings	1.50	0.50	1.82	0.73	-.590

Note. PLMSI = periodic leg movement sleep index (average number of leg movements per hour of sleep).