ARAŞTIRMA

THE INVESTIGATION OF SLEEP QUALITY OF PARKINSON'S DISEASE PATIENTS*

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ABSTRACT

This research was a descriptive study conducted for the purpose of examining the quality of sleep and factors that affect the quality of sleep of Parkinson's disease patients.

The research was conducted in the neurology clinic of a university hospital in Izmir, Turkey. The research sample comprised 103 patients who presented to the neurology clinic of the hospital with a diagnosis of Parkinson's disease. The research data were collected using a Patient Information Form and the Pittsburgh Sleep Quality Index. The research data were analyzed using Independent-Samples t test, tek yönlü varyans, Mann Whitney U and Kruskal-Wallis tests.

The majority of the patients (74.8%) were determined to have poor quality of sleep (Global PSQI Score >5), and the Global Pittsburgh Sleep Quality Index score mean was found to be 9.21 ± 4.54 (Range: 0-20). There was no significant difference in the patients' the Pittsburgh Sleep Quality Index mean score for different age groups. Female patients were found to have poorer sleep quality than male patients ($p<0.05$).

There is a need for further research to develop new methods of increasing the quality of sleep of Parkinson's disease patients.

Keywords: *Parkinson's disease, sleep quality, nursing, nurse*

ÖZET

Parkinson Hastalarının Uyku Kalitesinin İncelenmesi

Bu araştırma, Parkinson hastalarının uyku kalitesini ve uyku kalitesini etkileyen etmenleri incelemek amacıyla tanımlayıcı olarak yapılmıştır.

Araştırma İzmir'de bir üniversite hastanesinin nöroloji polikliniğinde yürütülmüştür. Araştırmanın örneklemini bir üniversite hastanesinin Nöroloji Polikliniğine başvuran, Parkinson tanısı almış ve araştırmaya katılmayı kabul eden 103 hasta oluşturmuştur. Araştırmanın verileri, hasta tanıtım formu ve Pittsburgh Uyku Kalitesi İndeksi kullanılarak toplanmıştır. Verilerin analizi, iki ortalama arasındaki farkın önemlilik testi, tek yönlü varyans analizi, Mann Whitney U ve Kruskal-Wallis Testi kullanılarak yapılmıştır.

Hastaların büyük çoğunluğunun (%74.8) uyku kalitesinin kötü olduğu saptanmıştır (Global PUKİ Puanı>5), Global ve Pittsburgh Uyku Kalitesi İndeksi puan ortalamasının 9.21±4.54 (Range: 0-20) olduğu bulunmuştur.

Yaş grupları açısından ve Pittsburgh Uyku Kalitesi İndeksi puan ortalaması arasında anlamlı bir fark yoktur. Kadın hastaların uyku kalitesinin erkek hastalara oranla daha kötü olduğu bulunmuştur ($p<0.05$).

Parkinson hastalarının uyku kalitesini arttırmada yeni yöntemler geliştirmek için ileri araştırmalara gereksinim vardır.

Anahtar kelimeler: *Parkinson hastalığı, uyku kalitesi, hemşirelik, hemşire.*

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INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative illness which presents in old age, and which is characterized by slow movements, resting tremors of the hands and, rarely, of the feet, muscular rigidity, and balance disorders (Çakmur 2003). In studies conducted in various societies the prevalence of PD has been reported to be 18-328/100 000 (Rajput and Birdi 1997). In a study conducted in Turkey the prevalence was reported to be 111/100 000 (Çakmur 2003). Studies have shown that it is common for PD patients to have sleep disorders (Shulman et al. 2001, Fabbrini et al. 2002) and that they can occur at any stage of the disease (Chaudhuri and Martinez-Martin 2004).

It has been reported that 42-98% of Parkinson's patients have poor sleep quality and that these values are higher than for healthy individuals in the same age group (Kumar et al. 2002, Oerlemans and de Weerd 2002). Sleep disorders occur in PD patients because of a combination of neurochemical and neurodegenerative changes in the central sleep regulatory centers such as the forebrain, thalamus and midbrain dopamine neurons (Chaudhuri et al. 2002). The sleep disorders that are seen in Parkinson's disease can be related to the symptoms of the disease, such as bradykinesia and rigidity, primary sleep disorders, medications, depression and dementia (Günal 2003). The basic problem is the many interruptions in sleep rather than difficulty in falling asleep. Patients spend a mean of 20-40% of their nights awake (Günal 2003). Medications that are used in treating Parkinson's disease can also cause sleep problems. For example, a high dose of levodopa taken before going to bed increases nighttime wakefulness, decreases REM sleep, and can cause hallucinations and confusion. Daytime sleep increases insomnia and causes a disturbance in the circadian rhythm. As the disease advances problems related to sleep and daytime sleepiness increase. In addition depression and dementia can complicate the situation (Günal 2003).

The lengthening of sleep latency and the number of awakenings tend to increase in proportion to the severity of Parkinsonian symptoms (Günal 2003). A majority (67%) of PD patients experience difficulty in falling asleep (Happe et al. 2005). Nausieda et al. (1982) determined that 74% of Parkinson's patients have interruptions in their nighttime sleep (Nausieda et al. 1982). In a study made by Happe et al. (2005) it was determined that Parkinson's patients, compared to healthy individuals in the same age group, have decreased subjective sleep quality, sleep duration and sleep effectiveness. In another study it was determined that 29% of Parkinson's patients use a hypnotic or sedative type of medication to be able to sleep at night (Lees et al. 1988). The nature of sleep in Parkinson's patients is one of the biggest reasons why these patients are dissatisfied with their quality of life (Stocchi et al. 1998).

The majority of Parkinson's patients (42-98%) have been determined to have problems with their quality of sleep (Kumar et al. 2002, Oerlemans and de Weerd 2002); however, there are no studies available in our country that have examined the quality of sleep of PD patients.

This research was a descriptive study conducted for the purpose of examining the quality of sleep and factors that affect the quality of sleep of PD patients.

METHODS

Sample

This research was conducted in the neurology policlinic of a university hospital between 6 October 2005 and 2 March 2006. There were 158 patients with a diagnosis of PD who were registered with the neurology policlinic of this university hospital and who attended the clinic regularly and chosen

by random sampling method. The research sample comprised 103 of these patients. Those included in the study could communicate verbally and agreed to participate in the study. Patients who had dementia, had difficulty with communication, or who did not agree to participate were excluded.

Instruments and Data Collection

Research data were collected by researchers in face-to-face conversation techniques using a Patient Introduction Form containing 7 questions relating to descriptive information of the patients, and the Pittsburgh Sleep Quality Index (PSQI) for the purpose of measuring their sleep quality.

The PSQI was developed in 1989 by Buysse et al. (1989) and was found to have adequate internal consistency (Cronbach's alpha = 0.80), test-retest reliability and validity (Buysse, Reynolds and Monk 1989). The validity and reliability tests of the PSQI for Turkish population were conducted by Ağargün et al. (1996) (Cronbach's alpha = 0.80). In our study, PSQI was found to have adequate internal consistency (Cronbach's alpha = 0.70).

The Pittsburgh Sleep Quality Index (PSQI) measures retrospective sleep quality and disturbances over a 1-month period, and is intended for use in clinical practice and research. The PSQI discriminates between good and poor sleepers, and provides a brief, clinically useful assessment of multiple sleep disturbances. Individual self-report items assess a broad range of domains associated with sleep quality, including usual sleep-wake patterns, duration of sleep, sleep latency, the frequency and severity of specific sleep-related problems, and the perceived impact of poor sleep on daytime functioning. Specific problems contributing to poor sleep that are assessed include pain, urinary frequency, breathing difficulty, snoring, dreams, temperature, etc.

The instrument consists of 19 items. There are 5 additional questions rated by the bed partner/roommate that are not included in the total score, but may be useful for clinical purposes. The 19 items are grouped into 7 equally-weighted component scores: 1) Subjective Sleep Quality (1 item); 2) Sleep Latency (2 items); 3) Sleep Duration (1 item); 4) Habitual Sleep Efficiency (3 items); 5) Sleep Disturbances (9 items); 6) Use of Sleeping Medication (1 item); and 7) Daytime Dysfunction (2 items). Items 1–4 are free entry of usual going to bed and waking times, minutes of total sleep time, and sleep latency (minutes). Items 5–18 are 4-point Likert scale responses pertaining to problem frequency: "not during the past month (0)"; "less than once a week (1)"; "once or twice a week (2)"; and "three or more times a week (3)." Item 19 is a 4-point Likert scale rating of overall sleep quality: "Very good (0)"; "Fairly Good (1)"; "Fairly Bad (2)"; "Very Bad (3)." The Global Score ranges from 0 to 21. All component scores range from 0 to 3. Higher Global Scores indicate poorer sleep quality.

An empirically derived cutoff score of >5 distinguishes poor sleepers from good sleepers. A Global Score of >5 indicates that a subject reports severe difficulties in at least 2 domains, or moderate difficulties in more than 3 areas (Smith and Wegener 2003).

Ethics

The research was conducted consistent with ethical principles. Permission to conduct the research was obtained in writing from the University Hospital and School of Nursing Scientific Ethics Committee and verbally from all of the patients who participated in the study.

Statistical Analyses

The research data were analyzed using independent-samples t test, One Way ANOVA, Mann Whitney U and Kruskal-Wallis tests.

FINDING AND DISCUSSION

The patients' mean age was 67.39 ± 9.47 (Range: 40-85) years, 41.7% were in the 65-74 year old age group, 51.5% were female, 35% were primary school graduates, and 77.7% were married. The mean duration of the disease was 7.30 ± 5.52 years (Range: 3 months – 35 years).

The majority of the patients (86.4%) did not exercise, and 69.9% had another health problem in addition to PD. The reasons why patients woke up at night were determined to be because of pain (63.7%), difficulty turning over in bed (72.8%) and nocturia (91.3%). The majority of the patients (71.8%) took naps during the day.

Quality of sleep means that when an individual wakes up he/she feels energetic and ready for a new day. This concept includes length of time taken to fall asleep, number of awakenings in the night, sleep duration, depth of sleep, and restfulness (Ertekin and Doğan, 1999).

The majority of patients (74.8%) in this study were found to have poor quality of sleep (Global PSQI Score >5).

Table 1. Patients' Sleep Quality Mean Scores

Sleep quality	Mean
PSQI global score	9.21±4.54
Subjective sleep quality	1.46±0.72
Sleep latency	1.45±1.31
Sleep duration	1.68±1.28
Habitual sleep efficiency	1.81±1.33
Sleep disturbances	1.50±0.68
Use of Sleeping Medication	0.56±1.08
Daytime dysfunction	0.71±1.00

Other studies that have examined the quality of sleep of PD patients have found between 42-98% of patients with poor quality of sleep (Kumar et al. 2002, Oerlemans and de Weerd 2002). The Global PSQI score mean for PD in our study it was determined that patients was found to be 9.21 ± 4.54 (Table 1). Shulman et al. (2002) reported a PSQI mean score for Parkinson's patients of 6.45 ± 4.74, Fabbrini et al. (2002) 7.4 ± 3.1, Shulman et al. (2001) 6.3 ± 4.5, and Iranzo et al. (2002) reported a PSQI mean score for advanced PD patients of 14.8 ± 4.5 (Shulman et al. 2001, Fabbrini et al. 2002, Iranzo et al. 2002, Shulman et al. 2002). The findings show that quality of sleep is an important problem for PD patients, and that it worsens as the disease advances.

In the examination of the score means of patients' PSQI components, it was determined that they experienced problems in components relating to subjective sleep quality, sleep latency, sleep duration, habitual sleep activities and sleep disturbances. The highest mean score was for habitual sleep activities (1.81±1.33) and the lowest mean score was for use of sleep medication (0.56±1.08) (Table 1).

In our study, the PSQI component of sleep latency had a low mean score (1.45 ± 1.31) (Table 1). The basic problem for PD patients was interruptions in sleep rather than difficulty in falling asleep (Günal 2003). Lengthening of sleep latency and number of awakenings tend to increase in proportion to the severity of Parkinsonian symptoms (Günal 2003). In the literature, it has been reported that 40-67% of PD patients have difficulty in falling asleep (Stocchi et al. 1998, Garcia-Borreguero et al. 2003). In a study by Factor et al. (1990) 66% of PD patients were found to have difficulty falling asleep, 88.5% had difficulty staying asleep, and the majority

woke up two to five times a night (Factor et al. 1990). Other studies have reported that PD patients have difficulty with interruptions in sleep from pain (75%), because they have difficulty turning over in bed (76%), and because of nocturia (80%) (Garcia-Borreguero et al. 2003). Kumar et al. (2002) reported that 38.92% of PD patients had difficulty turning over in bed, 70.46% had nocturia, and 26.17% had complaints of pain. In our study, it was determined that the reasons why patients woke up at night were because of pain (63.7%), difficulty turning over in bed (72.8%), and nocturia (91.3%).

The high percentage of these complaints in our study may be the reason why our patients had higher sleep disturbance mean scores than sleep latency mean scores. However the difference between the patients' sleep latency and sleep disturbance mean scores was not significant (Table 1). This result may be caused by disease symptoms that affect PD patients' sleep quality other than pain, nocturia and difficulty in turning, which were seen less in our patients, and which included medication use, dementia and depression. Other causes of sleep disturbance in PD that have also been reported in the literature include symptoms of the disease such as bradykinesia and rigidity (Garcia-Borreguero et al. 2003, Günal 2003), dementia and depression (Garcia-Borreguero et al. 2003, Askenasy 2005), and high doses of levodopa (Günal 2003).

In the examination of PSQI components score means, it was seen that the patients did not experience difficulties with components relating to the use of sleep medication or disturbances in daytime functioning (Table 1). The reason for this is presumed to be that the use of sleep medications is not common in this country and that the majority of our patients were retired, and therefore would not experience taking a nap as disturbance in daytime functioning.

Table 2. Distribution of PSQI Mean Scores of Parkinson's Disease Patients According to Their Individual Characteristics

Characteristics		**N**	**Mean (SD)**
Age Group (years)	*40-64*	31	7.87(3.99)
	65-74	43	9.46(4.19)
	75- ↑	29	10.27(5.34)
	KW=4.00 p= 0.13		
Gender	*Female*	53	10.54(4.55)
	Male	50	7.80(4.12)
	t= 3.20 p= 0.00		
Duration of Illness	*1-5 years*	32	6.50(3.71)
	6-10 years	34	9.23(4.09)
	11 years and ↑	37	11.54(4.38)
	F=13.028 p= 0.00		
Other Health Problem	*Yes*	72	9.69(4.52)
	No	31	8.09(4.47)
	t= 1.65 p= 0.10		
Difficulty Turning Over in Bed	*Yes*	75	10.29(4.36)
	No	28	6.32(3.73)
	Z=-3.93 u= 520.22 p=.00		
Exercising	*Yes*	14	6.92(3.51)
	No	89	9.57(4.60)
	Z=-2.08 u=407.00 p=.03		
Having napping	*Yes*	74	9.91(4.28)
	No	29	7.41(4.78)
	Z=-2.33 u=755.00 p=.01		

When factors that are thought to have an effect on sleep quality in PD patients were examined, no significant difference was found in PSQI mean scores for different age groups ($p>0.05$) (Table 2). The reason for this result is probably that the majority of the patients included in this study were aged 65 years and older. Other studies have found that older patients have worse sleep quality than younger patients (Ersser et al. 1999). However Nausieda et al. (1982) also did not find a correlation between age and the sleep disturbances seen in PD patients (Nausieda et al. 1982).

Female patients were found to have poorer sleep quality than male patients ($p<0.05$) (Table 2). It has also been reported in the literature than women have poorer sleep quality than men (Ersser et al. 1999). In a study made by Damiano et al. (1999), 25% of male PD patients and 41% of female patients had poor sleep quality; in another study, 25% of male patients and 48% of female patients had poor sleep quality (Damiano et al. 1999, Garcia-Borreguero et al. 2003). The reasons for the greater prevalence of insomnia in women have been determined to derive from the hormonal changes that occur with menopause, and from the fact that women experience more depression and other health problems that can disturb sleep (Ito et al. 2000).

In the research results it was determined that as the duration of the disease increased, so the quality of sleep worsened ($p<0.05$) (Table 2). In the study by Kumar et al. (2002) it was determined that as the duration of PD lengthened there was an increase in sleep problems. PD generally begins between 50-60 years of age and is a slowly progressive, chronic disease (Ertan 2005). As the duration of the disease lengthens, the worsening of symptoms and the intensive medication therapy may have adverse effects on the quality of sleep. However Nausieda et al. (1982) did not find a correlation between duration of PD and sleep disturbances.

No significant difference was found between PSQI score mean and whether or not the patients had a health problem other than PD ($p>0.05$) (Table 2). Tandberg et al. (1998) reported that 60% of PD patients, 45% of Diabetes Mellitus patients and 33% of healthy individuals have poor sleep quality. This result suggests that PD may have a more significant effect on sleep quality than the presence of other diseases.

It is known that healthy individuals change their position two to three times an hour while asleep. Bradykinesia in PD makes it difficult for patients to turn over in bed, and this causes them to wake up (Günal 2003). It was determined in our study that PD patients who had difficulty turning over in bed had poorer sleep quality ($p<0.05$) (Table 2). In a study by van Hilten et al. (1994) 50% of patients who had difficulty turning over in bed woke up frequently in the night. In a study by Oerlemans and de Weerd (2002) 72% of PD patients, and in a study by Lees et al. (1988) 76%, had difficulty turning over in bed.

It is known that exercise has a positive effect on falling asleep and sleep quality (Sasazawa et al. 1997). It was determined that patients who did not exercise had poorer sleep quality ($p<0.05$) (Table 2). Based on these findings it is suggested that exercise would facilitate PD patients' ability to turn over in bed and decrease the number of sleep interruptions.

Daytime sleepiness is frequently seen in PD (Tandberg et al. 1999). In our research 71.8% of the patients reported taking daytime naps. Oerlemans and de Weerd (2002) reported that 44% of PD patients take daytime naps, and Factor et al. (1990) reported 49%. Daytime sleeping increases nocturnal insomnia and causes disturbances in circadian

rhythm (Garcia-Borreguero et al. 2003). In our study it was determined that patients who took naps had poorer quality of sleep ($p<0.05$). It has also been reported in the literature that individuals who take daytime naps have poor quality of sleep (Ersser et al. 1999).

CONCLUSION

In conclusion, the Global PSQI score mean for PD patients was 9.21 ± 4.54 and the majority (74.8%) had poor sleep quality. This research presents data related to PD patients' sleep quality and factors that affect it.

Understanding the sleep problems of patients with PD improves management of the disease and the patient's quality of life. Nursing is a profession which helps to meet basic human needs, including the need for sleep. These results will guide the planning of nursing care for PD patients. It is recommended that nursing care planning be directed at the control of pain, bradykinesia and similar symptoms that can negatively affect sleep quality of PD patients, in order to improve their quality of sleep. It is recommended that nurses provide education to patients and their families on this subject. Further investigation is needed to examine the effects of the stages of a disease, medication, cognition, depression, dementia and symptoms.

REFERENCES

Ağargün MY, Kara H, Anlar Ö (1996). Pittsburgh Uyku Kalitesi indeksi'nin geçerliği ve güvenilirliği. Türk Psikiyatri Dergisi 7: 107-115.

Askenasy JJ (2005). Trying to understand sleep in parkinson's disease patients. Sleep and Biological Rhythms 3: 2-14.

Buysse DJ, Reynolds CF, Monk TH (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. Psychiatry Research 28: 193-213.

Çakmur R (2003). Parkinson hastaliğinin epidemiyolojisi ve klinik özellikleri. Türkiye Klinikleri Journal of Neurology 1: 160-163.

Chaudhuri KR, Martinez-Martin P (2004). Clinical assessment of nocturnal disability in Parkinson's disease. The Parkinson's Disease Sleep Scale. Neurology 63: 17-20.

Chaudhuri KR, Pal S, DiMarco A et al. (2002). The Parkinson's disease sleep scale: a new instrument for assessing sleep and nocturnal disability in Parkinson's disease. Journal of neurology, neurosurgery, and psychiatry 73: 629–635.

Damiano AM, Snyder C, Strausser B et al. (1999). A review of health-related quality-of-life concepts and measures for Parkinson's disease. Quality of Life Research 8: 235-243.

Ersser SJ, Wiles A, Taylor H et al. (1999). The sleep of older people in hospitals and nursing homes. Journal of Clinical Nursing 8: 360-368.

Ertan S (2005) Parkinson Hastalığının Klinik Özellikleri. İ.Ü. Cerrahpaşa Tıp Fakültesi Sürekli Tıp Eğitimi Etkinlikleri Nörolog Olmayanlar İçin Nöroloji Sempozyum Dizisi 42: 249-254.

Ertekin Ş, Doğan O (1999). Hastanede Yatan Hastalarda Uyku Kalitesinin Değerlendirilmesi, VII Ulusal Hemşirelik Kongre Kitabı, Erzurum, 22-24 Haziran, 222-227.

Fabbrini G, Barbanti P, Aurilia C et al. (2002). Excessive daytime sleepiness in de novo and treated parkinson's disease. Movement Disorders 17: 1026–1030.

Factor SA, McAlarney T, Sanchez-Ramos JR et al. (1990). Sleep disorders and sleep effect in Parkinson's disease. Movement disorders 5: 280-285.

Garcia-Borreguero D, Larrosa O, Bravo M (2003). Parkinson's disease and sleep. Sleep Medicine Reviews 7: 115-129.

Günal Dİ (2003). Parkinson hastaliği ve uyku bozukluklari. Türkiye Klinikleri Journal of Neurology 1: 218-222.

Happe S, Klösch G, Lorenzo J et al. (2005). Perception of sleep: Subjective versus objective sleep parameters in patients with Parkinson's disease in comparison with healthy elderly controls Sleep perception in Parkinson's disease and controls. Journal of neurology 252: 936–943.

Iranzo A, Valldeoriola F, Santamaria J et al. (2002). Sleep Symptoms and polysomnographic architecture in advanced Parkinson's disease after chronic bilateral subthalamic stimulation. Journal of

neurology, neurosurgery, and psychiatry 72: 661-664.

Ito Y, Tamakosshi A, Yamaki K (2000). Sleep disturbance and its correlates among elderly Japanese. Archives of Gerontology and Geriatrics 30: 85-100.

Kumar S, Bhatia M, Behari M (2002). Sleep disorders in parkinson's disease. Movement Disorders 17: 775-781.

Lees AJ, Blackburn NA, Campbell VL (1988). The nighttime problems of Parkinson's disease. Clinical Neuropharmacology 11: 512-519.

Nausieda PA, Weiner WJ, Kaplan LR et al. (1982). Sleep disruption in the course of chronic Levodopa therapy: an early feature of the Levodopa psychosis. Clinical Neuropharmacology 5: 183-194.

Oerlemans WG, de Weerd AW (2002). The prevalence of sleep disorders in patients with Parkinson's disease a self-reported, community-based survey. Sleep Medicine 3: 147-149.

Rajput AH, Birdi S (1997). Epidemiology of Parkinson's disease. Parkinsonism and Related Disorders 3: 175-186.

Sasazawa Y, Kawada T, Kiryu Y (1997). Effect of daytime exercise on sleep EEG and subjective sleep. Journal of Sound and Vibration 205: 393-403.

Shulman LM, Taback RL, Bean J et al. (2001). Comorbidity of the nonmotor symptoms of parkinson's disease. Movement Disorders 16: 507–510.

Shulman LM, Taback RL, Rabinstein AA et al. (2002). Non-recognition of depression and other non-motor symptoms in Parkinson's disease. Parkinsonism and Related Disorders 8: 193-197.

Smith MT, Wegener ST (2003). Measures of Sleep the Insomnia Severity Index, Medical Outcomes Study (MOS) Sleep Scale, Pittsburgh Sleep Diary (PSD), and Pittsburgh Sleep Quality Index (PSQI). Arthritis and Rheumatism (Arthritis Care & Research) 49: 184–196.

Stocchi F, Barbato L, Nordera G et al. (1998). Sleep disorders in parkinson's disease. Journal of Neurology 245: 15-18.

Tandberg E, Larsen JP, Karlsen K (1999). Excessive daytime sleepiness and sleep benefit in parkinson's disease: a community-based study. Movement Disorders 14: 922–927.

Tandberg E, Larsen JP, Karlsen KA (1998). Community-based study of sleep disorders in patients with Parkinson's disease. Movement Disorders 13: 895-899.

van Hilten B, Hoff JI, Middelkoop HA et al. (1994). Sleep disruption in Parkinson's disease. Assessment by continuous activity monitoring. Archives of Neurology 51: 922-928.