Comparing dementia patients' nighttime objective movement indicators with staff observation

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Abstract

Background: Pharmacological and non-pharmacological approaches are commonly used to treat patients institutionalized for nighttime wandering. Actigraphy and other scales have been used to evaluate the efficacy of these treatments. However, in clinical settings, nursing records are often the sole source of daily observation of nighttime wandering in patients. Physicians thus rely on nursing records to evaluate pharmacological and non-pharmacological treatments. This study examined nighttime movements of patients with dementia, comparing the results of integrated circuit (IC) tag monitoring with hourly nighttime nursing records. We tested which factors were associated with agreement rates between the two data sources.

Methods: The study hospital was a general hospital in Osaka, Japan. Monitoring was conducted in a closed 60-bed dementia care unit. An IC tag monitoring system (Matrix Co., Osaka, Japan) was used to monitor the movement of institutionalized dementia patients for over half a year. The distance moved per hour by subjects was measured using the monitoring system and the data were compared with hourly nighttime nursing records. Agreement rates were calculated between the two data sources.

Results: Thirty-five patients were monitored. Between 10-30% of subjects moved at any given hour during the night. The overall agreement rate between sources of movement data was 39%. Agreement rates were significantly correlated with the interquartile of the distance moved, changes in medication, physical

conditions and behavioral and psychological symptoms of dementia measured during the day.

Conclusions: Although the agreement rate was low, staff appeared to pay more attention to patients associated with notable events during the day and patients exhibiting variability in distance moved.

Keywords: dementia, nursing records, nighttime wandering, staff observation

Introduction

Wandering is the one of the most challenging behavioral and psychological symptoms of dementia (BPSD) manifested in people with dementia (PWD).[1,2,3] Nighttime wandering carries a particularly severe care burden for caregivers [4,5] and constitutes a risk factor for institutionalization. Pharmacological and non-pharmacological approaches are used to treat patients institutionalized for sleep-related problems. Actigraphy and measurement scales have been used to evaluate the efficacy of these treatments. [6] However, in clinical settings, nursing records of nighttime behavior often provide the sole source of daily observation of BPSD in individual patients. As such, physicians commonly rely on nursing records to evaluate pharmacological and non-pharmacological treatments. To date, the accuracy of nursing records on BPSD has not been systematically evaluated.

Previous studies of the accuracy of nursing records suggest that they do not provide an accurate reflection of patients' conditions.[7,8,9] A prospective study of pain in 65 post-surgical patients in the United Kingdom reported that nursing records identified pain as a problem in 34% of patients, whereas 91% of the participants directly reported pain to the researchers.[4] In a long-term care facility in the United States, residents and their primary nurses were interviewed about constipation, producing low to moderate concordance rates.[5] For example, of the 79 residents who reported no more than two bowel movements a week, only 24% of the primary nurses' reports concurred. Just over 50% of the nurses' reports

agreed with patients' reports regarding problems with fecal soiling or fecal incontinence.

The paucity of literature on the accuracy of nursing records on BPSD reflects limitations of the technology used to accurately measure various aspects of BPSD. A small number of attempts have been made to objectively measure wandering and sleep problems.[10,11] In two pilot studies, portable devices were used to measure movements or steps in institutionalized PWD for up to 4 hours.[12,13] These methods have not been used in subsequent studies because of the lack of precision and/or high removal rates of the devices. In contrast, the actigraph, which was developed to assess sleep disturbances, has been reported to exhibit validity and has been used to measure sleep/awake cycles and activity patterns in dementia patients.[14] However, actigraphy can only measure sleep/awake status and activity levels, not wandering. In addition, as dementia progresses, it becomes increasingly difficult to ensure the cooperation of patients in wearing the actigraph.

In recent years, the integrated circuit (IC) tag monitoring system (Matrix co., Osaka, Japan) have been used to measure distances moved by institutionalized PWD.[15,16] This system can monitor patients' temporal and spatial movements around the clock for an extended period of time.

The present study was a part of an IC tag monitoring project, which sought to develop a support system to aid nighttime monitoring of PWD. The purpose of the current study was 1) to describe patients' movements at night using objective measurement indicators and nighttime nursing records, 2) to compare nighttime

nursing records and objective measurement data, and 3) to examine the strengths and weaknesses of IC tag monitoring compared to nighttime nursing records

Methods

IC tag monitoring system

An IC tag monitoring system (Matrix Co., Osaka, Japan) was used to monitor the movement of institutionalized dementia patients for over half a year. Thirty antennas were strategically placed on the ceilings of patients' living spaces to monitor movement (Figure 1). The IC tag (46 mm × 30 mm × 11.5 mm; 15 g) was attached to each patient's shirt with adhesive tape. When a patient passed under an antenna, the tag emitted a signal identifying the time, tag ID and location. If the patient moved only within their room, the system could not detect the movement. The attachment of the IC tag for each patient was checked at least three times a day by the research assistant. The tag was reattached to a new shirt while the patient was taking a bath and after episodes of incontinence by the research assistant or unit staff.

Distances between antennas were used to estimate the distance moved per hour. More detailed descriptions of the system have been published elsewhere.[15,16] A number of other indicators have also been developed to describe temporal movements in dementia patients such as the distance moved per hour with movement.[17,18,19]

Setting

The study site was a closed 60-bed dementia care unit in the general hospital in Osaka, Japan. The primary reason for admission to this unit was BPSD that was unmanageable at home. The mean duration of hospitalization was approximately 3 months.

The unit corridor is approximately 90 m in total length. Except for six private rooms, each patient room had four beds, and toilets were accessible from the hallway, close to each room. There were 27 on-duty staff on average, of whom one-third were nursing aides. The nurse-to-patient ratio was 1:20, and the nursing aide-to-patient ratio was 1:25. The staff worked in three shifts. The night shift started at 23:30 and ended at 09:00. The staff-to-patient ratio during the night shift was 1:30, meeting the national standard. Two staff were present in the night shift.

Participants

Patients were generally able to carry out activities of daily living by themselves, in accordance with admission policy. Patients were monitored between September 2008 and April 2009. The eligibility criteria were 1) independent mobility and 2) meeting the diagnostic criteria for at least one of the following dementias: Alzheimer's disease [20]; vascular dementia [21]; frontotemporal dementia [22]; dementia with Lewy bodies [23]; and dementia related to alcoholism.[24] There were no exclusion criteria. However, if the patient could not be monitored

for a part of the day due to isolation or disrobing, that day was excluded from analysis.

Data collection

Demographic data were obtained from medical records. The patients' behavioral symptoms were evaluated using the Neuropsychiatric Inventory–Nursing Home Version (NPI-NH) [25] by a group of unit staff members during a regular weekly meeting. The Mini-Mental State Examination [26] was also administered by an experienced clinical psychologist.
Any changes in physical or mental condition, medication, or daytime napping habits were obtained from nursing records.

Nighttime movements according to data source

Night shift staff were required to observe and record the patients' nighttime status hourly. During their hourly rounds at night, if staff observed that a patient was not asleep, the patient's name was written on a nighttime status record, although it was not required to further specify awake status (e.g., moving/walking around inside or outside of room). This hourly check was a preexisting hospital policy for the closed unit.

For the purposes of this study, "night" was considered to be between 00:00 and 04:59, even though the night shift was from 21:00 to 06:00. Although the unit lights were turned off at 21:00, patients tended to remain awake later than 21:00,

and elderly patients tended to get up early in the morning; most of the patients were up by 06:00.

Data analysis

Objective indicators of patient movement measured by IC tag monitoring system

The following movement indicators were calculated (means were used when distribution was normal, and median was used when the distribution was skewed):

- Median distance moved per night (m).
- Percentage of hours with movement (%): (number of hours with movement) / (total number of hours monitored).
- Median distance moved per hour when in movement (m).
- Interquartile of the distance moved per hour with movement (m): 75th – 25th percentile of distances moved per hour with movement.

Agreement of patient movement data between IC tag monitoring system and hourly nighttime nursing records

If the IC tag data showed movement and the patient's name was recorded on the nighttime nursing record, the two data sources were considered to exhibit agreement. For example, if IC tag data indicated patient movement between 00:00 and 00:59, and the nighttime record recorded the patient as awake during either 00:00–00:59 or 01:00–01:59, agreement was considered to have occurred.

Agreement rates for each patient were calculated for the entire study period, as well as for the first 2 weeks of hospitalization, when closer observation was required by unit policy. This policy exists because dementia patients tend to have difficulties adjusting to new environments and BPSD can worsen during this period.

- Agreement rate for each patient (%): (number of hours for which data sources agreed) / (number of hours with movement)
- Percentage of days with notable daytime episodes or BPSD for each patient (%): (number of days with notable daytime episodes when data sources agreed) / (number of days when data sources agreed)

Factors associated with agreement rates

Spearman's rank correlation coefficients were calculated to examine factors associated with the agreement rate, such as demographic data and movement indicators, for the entire study period and for the first 2 weeks of hospitalization.

The Wilcoxon signed rank test was used to assess differences in the proportion of days with notable daytime episodes (napping during the day, fever during the day, and changes in medication) between nights when data sources agreed and nights when they disagreed. JMP ver. 8.0.1 for Windows (Suita, Japan) was used for statistical analysis. A value of $P < 0.05$ was considered significant.

Ethical considerations

The use of electronic device technology including the IC tag for monitoring dementia patients raises several ethical concerns. [27,28] Our research followed the principles and guidelines proposed by Mahoney et al.[27].

The research was approved by both the Ethics Committee of Osaka University's Graduate School of Medicine and the Ethics Committee of Asakayama Hospital. All authorized patient proxies were given explanations of the study protocol and the ethical considerations involved. Written informed consent was obtained from all patient proxies. If the patient showed any indication of refusal during the study period, the tag was not attached.

Results

Participants

Thirty-eight patients were recruited for the study. Of these, three could not be monitored because of disrobing behavior or required isolation. A total of 35 individuals were monitored, including two readmitted patients. The demographic and clinical characteristics of the patients are presented in Table 1.

Approximately two-thirds of the patients were men, and the majority exhibited Alzheimer's disease with moderate to severe dementia. The mean number of days of monitoring was 68.5 ± 43.9, ranging from 2 to 189 days.

Monitoring was successfully conducted on 94.7 ± 9.0% (range: 55.4%–100%) of the days that it was possible to monitor patients. The patient with the lowest monitoring rate occasionally experienced hallucinations and

tended to disrobe during such hallucinations. This patient was included in the analysis because she was cooperative with the monitoring project while she was not hallucinating. The primary reason for the <100% tag attachment rate was failure to attach the IC tag after a disrobing episode or changing the patient's clothes following an incontinence episode.

Distribution of the proportion of the events recorded from two data sources

Figure 2 shows the distribution of the events per hour per patient recorded from two data sources at night over the entire study period. The IC tag recorded approximately two-thirds of the total recorded events, and 20% of the IC tag movement events were also recorded in the nursing records. Approximately one-third of these events were recorded in the hourly nursing record, indicating the recorded event of being awake. The agreement rate between the two data sources regarding movement outside the patient's room was 39%.

Nighttime movements and agreement rates between IC tag data and nighttime nursing records for each patient

The mean percentage of nights with movement was 38.7 ± 30.2% (range: 0–97.6%). No nighttime movement was recorded in three patients. The mean distance moved per night was 78.9 ± 102.3 m, and the mean interquartile of distance moved per night was 131.3 ± 163.2 m.

The percentage of hours with movement among five 1-hour segments differed significantly (analysis of variance; ANOVA); *post-hoc* testing revealed that significantly more movement was observed from 04:00–04:59 compared to other hours (Table 2).

The mean agreement rate across the entire study period in 35 subjects was 24.3% (range: 0–59.2%; Table 2). This rate was 33.3% for the first 2 weeks of hospitalization.

The mean agreement rates across hours did not reach statistical significance ($P = 0.193$) (Table 2).

Factors associated with agreement rates for movement episodes

Agreement rates for movement episodes were not associated with patient age or cognitive function (Table 3). However, agreement rates were positively and significantly correlated with movement indicators; longer distances moved and higher fluctuations in the distance moved were associated with higher agreement rates (Table 3). When the data were limited to the first 2 weeks of hospitalization, correlation coefficients were slightly higher than those for the entire study period (Table 3).

Regarding BPSD, total NPI-NH scores as well as aberrant motor behavior and sleep subscale scores were not correlated with agreement rates in the first 2 weeks of hospitalization (Table 3).

Daytime notable episodes when both data sources agreed on night movements

The nights when both data sources agreed were significantly more likely to be associated with notable events (napping during the day, fever during the day, and changes in medication) compared to nights when they disagreed (Wilcoxon signed-rank test, $P < 0.01$) (Table 4). The type of event could not be stratified due to the small number of episodes.

Discussion

To our knowledge, the current report is the first study to objectively measure patients' nighttime movements, and examine the agreement between IC tag movement data and nighttime nursing records kept by the hospital unit staff. The IC tag data revealed that at any given hour during the night, 10–30% of monitored patients in this dementia care unit could be moving over a median distance of 36 m.

We found a low agreement rate between objectively measured movement and nighttime nursing records. However, factors associated with agreement rates indicated that staff paid selective attention to patients who also exhibited changes in physical and mental conditions. One possible reason for the low agreement rates is that the staff might not have had the opportunity to observe certain patients' movements because of the low staff-to-patient ratio during the night shift. A moderate correlation between the distance moved per hour and agreement rate indicates that longer distances moved by the patient were associated with a greater chance of being observed by staff. However, a stronger association between the interquartile of the distance moved and agreement rate

suggests that staff tended to document patients with greater fluctuations in the distance moved at night. In other words, staff tended to document a patient's status when it exceeded their expected norm for that patient.

In addition to movement indicators, the following factors were associated with higher agreement rates: daytime napping, daytime fever, and changes in medication. These are known risk factors for nighttime wandering,[1,2,3] and staff appeared to pay particular attention to patients exhibiting these conditions.

In contrast, BPSD measured by NPI-NH scores was not associated with agreement rates. NPI-NH is a summary measure of BPSD during the preceding week,[23] not a real-time measurement scale. Furthermore, subscales related to wandering and sleep disturbances do not ask detailed questions regarding what time of day wandering occurs. Overall, the present results indicate that scales to measure sleep problems or nighttime wandering over a week or longer do not correspond well with real-time measurement of movement at night.

A previous study in the Netherlands compared the Circadian Sleep Inventory for Normal and Pathological States (a scale to measure sleep disturbances) with actigraphy measurements, reporting a good correlation between the two measurements.[29] The caregiver-administered questionnaire items regarding habitual timing of sleep and wakefulness exhibited a good correlation with corresponding actigraphy measures[29]. However, the questionnaire and actigraphy variables correlated only modestly, indicating limitations of the caregiver's assessment.

Inaccuracy or underreporting of elderly patients' problems or behaviors are not unique to our study.[9,30,31] A Swedish study[6] reported that nurses tended to underreport problems they identified regarding mobility, sleep, nutritional intake, skin conditions, and mental conditions, among others. Of 10 problems reported by nurses in interviews, the percentage of problems documented in their nursing records varied from 11% for fluid intake to 59% for mobility. The study did not explore reasons for underreporting.

Implications for clinical practice

Improving the accuracy of nursing documentation is a universal challenge. A few studies have demonstrated the efficacy of interventions to improve nursing records. Hansebo *et al.* [30] conducted a monthly intervention study to improve nursing records over 1 year and reported increases in the number of items and volume of information recorded. Ehrenberg and Ehnfors [31] implemented an intervention program for nursing home staff to document specific health problems of residents, reporting that the intervention group exhibited an increased volume of documentation compared with the control group. These interventions indicate that education can improve patient assessments and documentation.

Because the staff in the study unit made a concerted effort to document events they felt were important, a simple system of flagging a patient requiring further documentation could improve the accuracy of nursing records. The current nursing records did not specify whether the patient was awake in bed or walking around. Further specification of patient status using acronyms (i.e. W for 'walking') could also improve differentiation of BPSD without increasing documentation time.

Advances in monitoring technology can assist in improving patient safety and documentation with minimal invasion of privacy. The IC tag monitoring system is in the developmental stage. While using it in this study, staff reported its usefulness for monitoring patients at risk of falling at night. For practical application, the IC tag attachment method should be refined, and the software upgraded to display descriptive statistics to understand the patient's activity level and rhythms. Such a monitoring system would be particularly helpful for patients with moderate to severe dementia, to monitor activity disorders and evaluate care.

Strengths and limitations

The main strength of this study was the description of nighttime movements of PWD using objective measurements (IC tag monitoring system) in addition to nighttime nursing records; this is the first study to document the frequency of late-night movement in dementia patients. Previous nursing record accuracy studies used interview data from elderly patients as a measure.[9,32,33] However, elderly patients may not be able to recall or state their problems accurately.

The primary limitation of our study was the extent to which staff could or did observe patient movements. Because IC tags were not used to assess the movement of staff through the unit, it is difficult to determine the extent of underreporting. Furthermore, differences in the accuracy of nursing records among the 20 staff were not examined. Nevertheless, certain features of the agreement rate data suggest selectivity in documentation.

As a further limitation, antennas were not placed in the patient's room due to budget limitations. Thus, the system could not capture movements within the patient rooms, or determine whether patients were awake while in bed. Thus, the IC tag is only useful for measuring sleep disturbances that manifest wandering outside the patient's room. Additional devices, such as an actigraph, are necessary to thoroughly measure sleep disturbances.

We are in the process of analyzing staff interview data, focusing on patients whose activity levels measured by the IC tag system differed substantially from the staff's assessment. Some patients' movements were largely unnoticed by the staff. This type of analysis is only possible following the collection of objective

data with methods like those used in this study. Future studies should examine methods of monitoring BPSD and the type of data required.

Conclusions

Patients moved during 40% of the nights monitored, with a mean distance of 36 m moved per hour, and a 39% agreement rate between the IC tag movement data and nighttime nursing records. Although under-reporting of patient movements occurred, staff appeared to pay selective attention to patients associated with notable events, and those exhibiting variability in the distance moved.

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