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A LONGITUDINAL STUDY OF POOR SLEEP AFTER INPATIENT POST-ACUTE REHABILITATION: THE ROLE OF DEPRESSION AND PRE-ILLNESS SLEEP QUALITY

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Abstract

Objectives—To explore the unique impact of poor sleep and symptoms of depression on sleep quality for up to one year after inpatient post-acute rehabilitation among older adults.

Design—Prospective longitudinal cohort study.

Setting—Two in-patient post-acute rehabilitation facilities

Participants—245 individuals over age 65 years (mean age=80 years, 38% female)

Interventions—None.

Measurements—Sleep quality was assessed with the Pittsburgh Sleep Quality Index (PSQI) during the post-acute care stay twice to evaluate pre-illness sleep quality and sleep quality during the post-acute care stay, and again at 3, 6, 9 and 12-months follow-up. Demographics, symptoms of depression, cognitive functioning, and comorbidities were also assessed.

Results—Across time points, sleep was significantly disturbed for many individuals. Nested regression models predicting PSQI total score at 3, 6, 9 and 12 months showed that variables entered in Block 1 (age, gender, cognitive functioning and comorbidities) were significant predictors of poor sleep at 6-months, but not at 3, 9 or 12 months follow-up. Depression (Block 2) and pre-illness PSQI total score (Block 3) were significant predictors of PSQI total score at all follow-up time points. PSQI total score during post-acute care (Block 4) explained a significant proportion of variance only at the 3-month follow-up.

Conclusions—This study confirms that chronic poor sleep is common among older adults during post-acute rehabilitation, and resolution of sleep disturbance after acute health events may be a lengthy process. Our findings expand understanding of the role of depressive symptoms and pre-existing sleep complaints in predicting poor sleep over time among these vulnerable older adults.

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Keywords

rehabilitation; sleep; aging; depression

OBJECTIVE

Chronic sleep problems are a serious health concern among older adults, and studies estimate that 5% of older adults develop insomnia each year.¹ Importantly, insomnia and other sleep disturbances are hallmark symptoms of depression, yet despite this overlap, these two conditions are not always addressed simultaneously in research. When sleep and depression have been examined together among older adults, findings suggest there is some overlap. In a cross-sectional study of Japanese-American older adults, people who reported having sleep problems also reported increased rates of depression and anxiety.² Longitudinal studies of older adults have found that insomnia predicted depression 1 to 3 yrs later.^{1,3} In a study of 292 patients in an ambulatory care clinic, almost half of the patients who reported depressive symptoms at baseline continued to report symptoms at 9 month follow up suggesting that depression is persistent over time.⁴ In addition, depression is more common among older adults with chronic health problems, and studies suggest it is common among older adults following acute health events as well.⁴⁻⁶ Notably, research shows that depression is also associated with higher rates of daytime napping among older adults.⁷

Older adults commonly suffer from multiple chronic conditions that can lead to hospitalization. In 2007, more than 3 out of 10 older adults in the US were admitted to an acute care hospital, with an average length of stay of 5.6 days.⁸ When older adults are discharged from acute settings, they often receive inpatient rehabilitation in “post-acute” settings. In these settings, patients participate in physical, occupational and other therapies to improve their functional independence and facilitate return to their prior place of residence. Theoretically, an acute change in health that leads to hospitalization may represent a “trigger” that changes sleep habits and leads to symptoms that can cause or perpetuate poor sleep quality for extended periods of time. To date, little research has explored factors that predict sleep problems prospectively, particularly in the context of acute changes in health.

Prior research shows that sleep quality in acute care hospitals and rehabilitation settings is poor, and some studies show sleep problems persist after discharge.^{9,10} Poor sleep in inpatient settings is likely the result of a combination of patient-level factors such as pain, and facility-level factors such as noise and interruptions at night to provide care. In our prior work, we found that sleep disruption in the post-acute care setting was associated with less improvement in functioning and shorter survival over the year following discharge from post-acute rehabilitation.^{11,12}

Symptoms of depression are associated with less functional improvement during rehabilitation, and higher mortality risk after rehabilitation.^{13,14} Studies show that depression can both precede and follow acute health events. In a study of patients who had surgical procedures after a hip fracture, individuals were at elevated risk for major depressive disorder immediately after surgery, even if they reported no depressive symptoms at admission.¹⁵ Also, depressive symptoms among hip fracture patients have been associated with worse recovery in both functional and psychosocial status.¹⁶ A recent study also showed that depressive symptoms predicted development of disability or increase in disability severity of an 18-month period among persons over age 70.¹⁷ One caveat of these studies is that they did not simultaneously evaluate the impact of poor sleep on the outcomes of interest.

Despite the fact that depression and poor sleep commonly co-occur, few studies have examined these two symptoms simultaneously in older adults, and we are not aware of any studies that have examined these symptoms simultaneously as predictors of chronic poor sleep among older adults during recovery from health events. In the MrOS study, which included over 3000 older men, researchers found that individuals with depressive symptoms were at higher risk for subjective sleep disturbances based on self-report or objectively-measured sleep disturbances at a single time point.¹⁸ The goal of the present study was to fill a gap in the existing literature by exploring the unique impact of poor sleep and symptoms of depression during post-acute care on long-term sleep quality. We sought to examine the role of poor sleep quality before hospitalization and during post-acute care, and symptoms of depression as predictors of poor sleep for up to one year after post-acute rehabilitation. We hypothesized that symptoms of depression would predict poor sleep over the one-year follow-up period. We also hypothesized that poor sleep prior to and during the post-acute care stay would predict poor sleep over the one-year follow-up period.

METHODS

Participants

Within a prospective cohort study of older post-acute rehabilitation patients, 245 individuals over the age of 65 (mean age=80 years, 38% female) had their sleep quality assessed in the post-acute care setting and at 3, 6, 9 and 12 months follow-up. A detailed description of the participants enrolled in this study from two post-acute care sites has been published previously.¹¹ Briefly, the first post-acute care site was a freestanding, for-profit, community nursing home which focused on short-term rehabilitation, and the second was an inpatient rehabilitation unit within a Veterans Administration Medical Center. At both sites, all patients admitted who were over 65 years of age (n=996) were approached for screening as soon as possible (on average, 4 days) after admission. Only participants admitted for rehabilitation (i.e., to receive physical, occupational or kinesiotherapy) were eligible. Exclusion criteria were: 1) residing in a nursing home as a long-stay resident prior to admission, 2) being unable to participate in the study due to a severe medical illness (e.g., end of life care) or severe behavioral disturbance (e.g., dementia with severe agitation identified on screening interview), and 3) being unable to communicate verbally in English during the screening process. A total of 938 individuals (97%) agreed to screening, of whom 737 (79%) met the eligibility criteria listed above. Thirty-three percent (n=245) of eligible individuals were enrolled into the study and provided written informed consent. If the patient was unable to self-consent, proxy consent (with the assent of the participant) was obtained. All research methods were approved by the Veterans Administration Greater Los Angeles Healthcare System Institutional Review Board.

Procedures

All data were collected by trained research personnel for research purposes only. After enrollment, participants completed a baseline assessment which included a series of questionnaires administered in interview format. This questionnaire battery (described in detail below) was completed during two separate interviews; the first immediately after enrollment, and the second one week later. If the participant was discharged in less than one week (n=6), an attempt was made to complete the assessments prior to discharge. After the participant was discharged from the rehabilitation facility, a structured medical record review was completed by a trained research nurse to determine reason for rehabilitation admission, medications taken in the rehabilitation facility, length of acute hospital stay before admission for rehabilitation, and to obtain medical record information needed for completion of the comorbidity measure (described below).

In-person follow-up assessments were conducted at the participant's place of residence 3-, 6-, and 9-months from the date of admission to the rehabilitation facility. When an in-person visit was not possible (e.g., participant had moved away or preferred not to have a research assistant visit his/her home), the assessment was performed by telephone (33% of all follow-up interviews). Twelve months after admission, the questionnaire battery was completed by telephone for all participants.

Sleep Measures

The main measure of self-reported sleep quality was the Pittsburgh Sleep Quality Index (PSQI). The PSQI is a 19-item questionnaire (score range 0-21) that assesses overall sleep quality. Typically, a PSQI total score greater than 5 suggests clinically significant sleep disturbance.

For this study, the PSQI was administered twice during the post-acute care stay (pre-illness PSQI, 7-day PSQI), and again at 3, 6, 9 and 12-months follow-up. On enrollment, participants were queried about their sleep for a one-month period "before their recent illness" (pre-illness PSQI). As such, the pre-illness PSQI was intended to describe sleep patterns before the events that precipitated hospitalization and the rehabilitation facility stay. The PSQI was administered a second time one week after enrollment (for 2 participants discharged in less than one week, the PSQI was administered within less than one week of the pre-illness PSQI), and participants were queried about their sleep over the prior week, during their post-acute rehabilitation stay (7-day PSQI). Then, at 3-month intervals, participants were contacted as described above and the PSQI was repeated, querying about sleep quality over the prior week (to maintain consistency with the in-patient recall time frame). The PSQI measured at the follow-up time points represents the main outcome measure for the current analyses.

Other measures

Basic demographic information was recorded for all participants, including age, gender, ethnicity and reason for admission to the rehabilitation facility, from the transferring hospital discharge records and review of the rehabilitation facility medical record. The total number of hours of rehabilitation therapy received (i.e., physical therapy, occupational therapy, kinesiotherapy) was also calculated from therapists' notes in the medical record. Rehabilitation services were provided six days per week at one facility, and five days per week at the other. To enhance comparability across sites, we calculated the mean number of minutes of therapy received on the days therapy services were available.

During the interviews conducted during the post-acute care stay, general cognitive functioning was assessed with the Mini-Mental State Examination (MMSE), a 20-item measure where higher scores suggest better cognitive functioning (score range=0-30).¹⁹ Symptoms of depression were also assessed with the 15-item version of the Geriatric Depression Scale (GDS-15; score range=0-15).²⁰ The GDS-15 total score was used as the main measure of symptoms of depression.

To assess baseline illness severity and comorbidities, the Cumulative Illness Rating Scale for Geriatrics (CIRS-G) was used.^{21;22} The CIRS-G was completed by an experienced research registered nurse, using data collected from a structured medical record review and a brief physical examination by a study physician. Medications received and transfer to an acute care hospital during the rehabilitation stay were recorded from facility records. An acute care hospital transfer (e.g., due to an acute illness occurring during the rehabilitation stay) was defined as spending one or more days in an acute setting between the initial admission and final discharge from the rehabilitation facility. Participants who did not return

to the rehabilitation facility after transfer to an acute care hospital were considered discharged from the facility on the date of transfer.

Statistical Analysis

Other than an expected gender difference (43.0% vs. 96.6% men at facilities A and B, respectively), as previously reported, there were few differences in demographic characteristics across the study sites and no differences in sleep;¹¹ therefore findings here are presented for the combined sample. Descriptive statistics for the entire sample are shown in the first column of Table 1.

To examine the roles of poor sleep and symptoms of depression, a set of nested regression models (sometimes referred to as hierarchical regression models) were used.²³ This method, in which variables are entered into the regression model in “blocks”, allowed assessment of the variance uniquely explained by depression (GDS-15), pre-illness sleep disturbance (pre-illness PSQI), and sleep disturbance during post-acute rehabilitation (7-day PSQI) separately. The first “block” of variables entered into the model represented a set of variables known to impact sleep from previous studies, including cognitive functioning (MMSE), comorbidities (CIRS-G), age, and gender. The second block included the GDS-15 total score. The third block included the pre-illness PSQI score, and the fourth block included the 7-day PSQI score. For each block, an F-test was calculated assessing the significance of the variable(s) entered within that particular block. In addition, the change in R^2 was computed to show the additional variance explained by the variables in each block, above and beyond the variance explained by previous blocks entered into the model. This approach was used to test four statistical models where the outcome variables were the PSQI total scores collected at 3, 6, 9 and 12 months follow-up.

As the sample sizes were not equivalent for each of the follow-up time points due to missing data for some participants. At 3-months follow-up, 16 individuals were deceased and 37 refused to complete the assessment; at 6-months, 41 were deceased and 42 refused to complete the assessment; at 9-months, 47 were deceased and 43 refused to complete the assessment, and at 12-months, 57 were deceased and 27 refused to complete the assessment. Additionally, some participants only partially completed the assessment resulting in exclusion of their data from the regression models tested. Descriptive statistics are shown in Table 1 for the cohort included in the regression model for each of the four time points outlined above (i.e., one per follow-up time point). Two sample t-tests were used to assess differences in the variables studied between participants included in each of the regression models versus those who were excluded due to missing data, and differences are described below. For all statistical tests, a p-value of <0.05 was considered statistically significant. Analyses were conducted using STATA Version 11.2.

RESULTS

Self-reported Sleep Quality and Depression over Time

Across time points sleep was significantly disturbed for a large number of individuals. Figure 1 shows the proportion of participants with PSQI scores greater than 5 (traditional cutoff for clinically significant sleep disturbance) at each time point. The mean (SD) pre-illness PSQI score was 5.2 (3.8), the mean (SD) 7-day PSQI score was 8.4 (4.4), and the mean (SD) PSQI scores at 3, 6, 9 and 12-month follow ups were 6.5 (3.8), 6.6 (3.8), 6.7 (3.8) and 6.0 (3.6), respectively.

Mean (SD) GDS-15 score during rehabilitation was 4.1 (3.3), and the mean GDS-15 scores at 3, 6, and 9-month follow ups were 4.6 (3.5), 4.3 (3.2) and 4.5 (3.2), respectively [note: GDS-15 was not completed at 12-months]. Descriptive information about baseline self-

reported sleep (based on the PSQI) and GDS-15 score is shown in the first column of Table 1 for the entire sample.

Predictors of Self-reported Sleep Quality at Follow-up

The results of the nested regression models predicting PSQI total score at 3 months (model 1), 6 months (model 2), 9 months (model 3), and 12 months (model 4) are summarized in Table 2. This table shows the significance of the variables entered in each block, the R^2 for the variables in the current and previous block(s), plus the R^2 change, which represents the significance of variables in blocks 2-4, after accounting for the variance explained in prior blocks.

The results show that variables entered in Block 1 (age, gender, MMSE, and CIRS during rehabilitation) were not significantly related to poor sleep at 3, 9 or 12 months follow-up, but were significant at 6-months follow-up. The GDS-15 total score during post-acute rehabilitation (block 2) was a significant predictor of PSQI total score at all four follow-up time points. The contribution of pre-illness PSQI total score (block 3) accounted for a significant proportion of the variance in PSQI total score at all four follow-up time points above and beyond the block 1 and 2 variables. The PSQI total score during post-acute care (7-day PSQI; block 4) explained a significant proportion of variance only at the 3-month follow-up time point above and beyond variables entered in blocks 1-3.

DISCUSSION

Significant sleep disturbance was common at all time points in this study. The best sleep was reported prior to illness onset, and rates of poor sleep remained high 12 months after enrollment into the study. This study confirms that chronic poor sleep is common among older adults who have health problems and that resolution of sleep disturbance after acute health events may be a lengthy process. In addition, our findings expand understanding of the role of depressive symptoms in predicting poor sleep over time.

Our hypothesis that depressive symptoms during the post-acute care stay predicted poor sleep after discharge was confirmed. We were somewhat surprised, however, by the strength of the association seen. In fact, depressive symptoms accounted for 8-27% of the variance in PSQI total score at the follow-up time points above and beyond the covariates. While depression is frequently considered a consequence of poor sleep, and poor sleep can be a symptom of depression itself, our findings suggest that symptoms of depression during the post-acute care stay predict poor sleep over the long-term. Strikingly, symptoms of depression during the post-acute care stay predicted sleep quality for up to one year after the depressive symptoms were assessed. We previously reported that depression is seldom recognized in these settings, and screening for depression during post-acute care may lead to improved access to treatment for depression.²⁴ It remains unknown whether treating depression will reduce chronic sleep disturbance among older adults, and additional research in this area is needed.

The findings related to pre-illness sleep quality and sleep quality during post-acute rehabilitation depict a complex relationship in which poor sleep prior to the acute health event precipitating hospitalization was associated with poor sleep for up to one year after that event. However, poor sleep during post-acute care predicted poor sleep only at the 3-month follow-up time point, and not at the 6, 9 or 12-month follow-up time points. Given that individuals “lost to follow-up” by one year were older, had more comorbidities and worse cognitive functioning, it is possible that those who were most impaired were deceased or lost for other reasons by one year after enrollment. This does suggest, though, that acute sleep disturbance (during the post-acute care stay) might resolve within a few months, while

poor sleep that pre-dated the acute health events was unlikely to improve. It also suggests that the pre-illness PSQI format captured chronic sleep disturbances, rather than simply capturing sleep quality during the hospital stay. We found the magnitude of these effects to be quite impressive, with pre-illness PSQI score accounting for 13-19% of the variance in PSQI total score at follow-ups, above and beyond the covariates and depression scores.

A key implication of our findings relates to interventions to improve sleep among older adults recovering from acute health events. Our findings suggest that treatments addressing chronic sleep difficulties might be preferred to treatments that improve sleep over the short-term in the inpatient setting. For example, individuals with significant sleep disturbance could be treated with evidence-based non-pharmacological treatments, such as cognitive-behavioral therapy for insomnia instead of – or in addition to – being given sedative-hypnotic medications during hospitalization.

This study has several strengths including the prospective, longitudinal design and the ability to account for important covariates, including cognitive functioning and illness burden. Nonetheless, the study does have limitations that must be considered when interpreting our findings. First, the enrollment rate into the study was low, with only one third of eligible individuals agreeing to participate which may impact the generalizability of our findings. Second, we did not report findings based on objective monitoring of sleep. In the larger study, we attempted to gather wrist actigraphy data to objectively characterize sleep; however this was difficult to complete at the follow-up time points, and we were concerned that high rates of missing data would make interpretation of our findings difficult. Third, some of the follow-up assessments (and all of the 12-month assessments) were completed by telephone rather than in person. While this may have improved our ability to gather data, differences in methods may have some minor impact on our findings. Lastly, rates of missing data at follow-up was high. This was, in part, due to a high mortality rate in this study with about one forth of participants deceased within 1 year.¹² In addition, some participants moved out of the area or refused to complete the follow-up assessments at various points during the study. As noted in table 1, individuals excluded from the statistical models due to missing data on one or more measures did differ from individuals included in the models, such that those not included tended to be older and more impaired than those included in the models across most measures.

Taken together, these findings suggest that both depressive symptoms during recovery from illness and poor sleep that pre-dated acute health events could be targeted for intervention in the post-acute care setting. A comprehensive approach targeting both symptoms of depression and chronic sleep disturbance will likely lead to the greatest reductions in chronic sleep difficulties. Ultimately, this may reduce the morbidity and mortality associated with chronic sleep difficulties among older adults and improve the trajectory of illness recovery.

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Figure 1. Percentage of participants with Pittsburgh Sleep Quality Index (PSQI) total scores above the clinical cutoff of 5 at each study time point.

Table 1

Characteristics of study participants at baseline, and of study participants included in analyses of each follow-up time point.

Variable	Total baseline sample Mean (SD) or n (%)	Included participants at each follow-up time point			
		3-month follow-up Mean (SD) or n (%)	6-month follow-up Mean (SD) or n (%)	9-month follow-up Mean (SD) or n (%)	12-month follow-up Mean (SD) or n (%)
N	245	120	84	89	87
Age, in years	80.6 (7.2)	79.2 (6.5) ^{*a}	79.5 (6.5) ^a	78.4 (6.3) ^{*a}	78.5 (6.8) ^{*a}
Gender, female	93 (38.0%)	34 (28.3%) ^{*b}	22 (26.2%) ^{*b}	24 (27.0%) ^{*b}	27 (31.0%) ^b
Ethnicity, non-Hispanic white	195 (79.6%)	88 (73.3%) ^{*b}	63 (75.0%) ^b	65 (73.0%) ^b	64 (73.6%) ^b
Orthopedic reason for admission to rehabilitation	90 (36.7%)	53 (44.2%) ^{*b}	44 (52.4%) ^{*b}	43 (48.3%) ^{*b}	45 (51.7%) ^{*b}
Days in hospital prior to rehabilitation	10.9 (15.8)	9.8 (19.5) ^a	7.5 (6.7) ^{*a}	7.7 (7.0) ^{*a}	7.8 (6.5) ^{*a}
Days in rehabilitation facility	21.4 (14.5)	19.9 (11.3) ^a	17.7 (10.0) ^{*a}	18.1 (10.9) ^{*a}	18.6 (10.1) ^{*a}
Number of medications received	15.9 (7.2)	16.9 (7.7) ^{*c}	17.4 (7.4) ^{*c}	17 (7.1) ^c	16.8 (6.9) ^c
Motor component: Functional Independence Measure (mFIM) total score	44.8 (12.5)	47.5 (11.2) ^{*a}	48.9 (10.7) ^{*a}	48.1 (11.1) ^{*a}	49.4 (10.9) ^{*a}
Mini-Mental State Examination, total score	23.5 (6.2)	25.5 (4.1) ^{*d}	25.8 (3.7) ^{*d}	26.4 (3.0) ^{*d}	26.6 (2.9) ^{*d}
Cumulative Illness Rating Scale-Geriatrics, total score	22.6 (5.9)	21.7 (5.8) ^{*a}	21.0 (5.6) ^{*a}	20.6 (5.5) ^{*a}	20.4 (5.5) ^{*a}
Geriatric Depression Scale-Short Form, total score	4.1 (3.3)	3.7 (3.1) ^{*d}	3.4 (2.7) ^{*d}	3.6 (2.8) ^d	3.4 (2.9) ^{*d}
Pittsburgh Sleep Quality Index (PSQI) total score, pre-illness	5.2 (3.8)	5.5 (3.9) ^e	4.8 (3.6) ^e	4.8 (3.5) ^e	4.9 (3.7) ^e
Pittsburgh Sleep Quality Index (PSQI) total score, during inpatient rehabilitation (7-day)	8.4 (4.4)	8.2 (4.1) ^f	7.6 (4.0) ^{*f}	7.7 (4.0) ^{*f}	8.2 (4.2) ^f

* Participants included in the model were statistically different from those excluded from the model (p<.05 using t-tests)

^a (df=1,243),

^c (df=1,242),

^d (df=1,226),

^e (df=1,212),

(system
 $\chi^2_{df=1,189}$
 f^2)

Table 2

Regression models predicting sleep quality (PSQI total score) at 3, 6, 9 and 12 months after inpatient post-acute rehabilitation.

Outcome	3-month PSQI total score				6-month PSQI total score				9-month PSQI total score				12-month PSQI total score			
	F (df)	p- value	R ²	R ₂ Δ	F (df)	p- value	R ²	R ₂ Δ	F (df)	p- value	R ²	R ₂ Δ	F (df)	p- value	R ²	R ₂ Δ
Block 1: Age, female gender, MMSE score, CIRS score	0.89 (4,115)	.475	.030	--	2.54 (4,79)	.047	.114	--	1.13 (4,84)	.348	.051	--	0.92 (4,82)	.456	.043	--
Block 2: GDS-15 score	9.55 (1,114)	.003	.105	.075	15.93 (1,78)	<.001	.264	.150	32.29 (1,83)	<.001	.317	.266	10.74 (1,81)	.002	.155	.112
Block 3: pre- illness PSQI score	18.88 (1,113)	<.001	.233	.128	16.03 (1,77)	<.001	.391	.127	32.03 (1,82)	<.001	.509	.192	16.84 (1,80)	<.001	.302	.147
Block 4: in- rehabilitation (7- day) PSQI score	6.93 (1,112)	.010	.278	.045	3.63 (1,76)	.060	.419	.028	0.32 (1,81)	.571	.511	.002	1.72 (1,79)	.194	.317	.015
Overall model	6.15 (7,112)	<.001	.233*	--	7.82 (7,76)	<.001	.365*	--	12.08 (7,81)	<.001	.468*	--	5.23 (7,79)	<.001	.256*	--

* Adjusted R²