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Sleep problems worsen health-related quality of life and participation during the first 12 months of stroke rehabilitation

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Abstract

Objective: Evaluate the impact of self-reported sleep problems on post-stroke recovery.

Design: Cross-sectional secondary analysis of longitudinal data from the Locomotor Experience Applied Post-Stroke (LEAPS) rehabilitation and recovery study (phase-III single-blind randomized controlled clinical trial). Group medians were compared for three sleep problem groups across three time points.

Setting: Outpatient and in-home physical therapy.

Subjects: Adults during the first year following stroke (n = 408, 380, 360 at 2, 6, 12 months, respectively).

Interventions: The original study compared effects of locomotor training with body weight support in the year post-stroke. This analysis evaluated function in three sleep/functional-impact groups: no sleep problems, sleep problems with no-to-minimal-impact and sleep problems with moderate-to-quite-a-bit of impact.

Main measures: Participants' responses regarding if they had "a sleep problem, such as insomnia" and, if so, what the impact was on their function. Stroke Impact Scale subscales for strength, hand function, mobility, ADLs, memory, communication, emotion, participation, and percent recovery.

Results: About 25% of people with stroke reported sleep difficulty, 10% perceived sleep problems negatively impact function. Groups self-reporting worse sleep performed worse in all functional subscales (except self-perceived percent recovery) during the first year post-stroke.

Conclusion: Self-reported poor sleep adversely effects post-stroke functional recovery.

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Author contributions

G.F. and K.K. conceived the idea for the analyses. G.F. performed the statistical analyses. P.D. supplied data files, and consultation regarding the original LEAPS study. All authors contributed to report writing and manuscript preparation, and accept responsibility for accuracy of the contents.

Declaration of conflicting interests

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Keywords

Sleep wake disorders; stroke; rehabilitation; physical therapy modalities

Introduction

Self-reported sleep impairment and poor sleep quality are associated with worse functional and mood-related outcomes following stroke.[1–3] Sleep impairment and poor sleep, in addition to being secondary symptoms of diseases such as stroke, can result from diagnosable (and treatable) sleep disorders such as obstructive sleep apnea, insomnia disorder, and restless legs syndrome. The stroke-sleep literature has focused primarily on obstructive sleep apnea, known to be both a risk factor and consequence of stroke,[4–10] and to negatively impact functional outcomes after stroke.[11,12] Insomnia is also problematic in persons with stroke, according to a recent meta-analysis that found insomnia diagnoses and insomnia symptoms are more prevalent in persons following stroke than in the general population.[13] Previous studies, however, have not examined the impact of sleep disorders in people with stroke on health-related quality of life and participation during stroke recovery.

Rehabilitation post-stroke requires intensive practice of skilled motor tasks. The ability to learn or re-learn motor skills is a critical component of rehabilitation. There is a growing body of evidence that sleep plays a vital role in motor learning and the acquisition of motor skills in people with stroke.[14–19] Stroke rehabilitation interventions, however, do not typically account for the potential adverse effects of disordered sleep on post-stroke recovery. It may be possible to enhance post-stroke recovery by treating disordered sleep across the acute, short-term, and chronic phases of recovery. An understanding of the complex interplay between disordered sleep and post-stroke recovery is required to determine whether such an approach might be viable. As a first step, therefore, the purpose of this study was to evaluate the impact of self-reported sleep problems on recovery of health-related quality of life and participation in people with stroke.

Methods

In this study, we performed a secondary analysis of sleep-related data from the Locomotor Experience Applied Post-Stroke study.[20,21] No results regarding the sleep aspects of the LEAPS study have been reported prior to our current undertaking. The Locomotor Experience Applied Post-Stroke study (clinical trials number NCT00243919,[22] which ran from April 2006 through June 2012) was a phase III single blind, randomized controlled trial designed to determine the effect of early (delivered at two months post stroke) or late (delivered at six months post stroke) locomotor training with body weight support and treadmill system compared to a home exercise program. Inclusion criteria for the Locomotor Experience Applied Post-Stroke trial were recent stroke (ischemic or hemorrhagic) confirmed by imaging or clinical presentation, ability to walk at least 3 m with at most maximal assistance, gait speed <0.80m/s, and lower extremity hemiparesis. After screening at 5 to 30 days post stroke, participants in the Locomotor Experience Applied Post-Stroke trial were randomized to one of three groups: early locomotor training with body weight support (at two months post stroke), home exercise program (at two months post stroke), and late locomotor training with body weight support (at six months post stroke). The intervention sessions in all three groups were 90 minutes in length and provided three times a week for 12 to 16 weeks so that participants completed between 30 and 36 sessions. See Duncan et al.[20,21] for more detail on the inclusion/exclusion criteria and the intervention.

Ethics

The appropriate Institutional Review Boards approved the original Locomotor Experience Applied Post-Stroke trial and all participants provided informed consent.[21,22] The original study was sponsored by the US National Institutes of Health and monitored throughout by a data safety monitoring board. This secondary analysis of de-identified data was ruled exempt by the author's Institutional Review Board.

Study measures

In this study, we used Locomotor Experience Applied Post-Stroke data collected at 2, 6, and 12 months post stroke. At each of these time points participants were asked a series of questions related to potential co-morbidities they may have been diagnosed with, and the perceived impact of the co-morbidity on function. One question asked if the participant had a "sleep problem, such as insomnia." If the participant answered yes, then they were asked to rate the functional impact of the problem on a 4-point ordinal scale: 1 =not at all, 2 = a little bit, 3= moderately, and 4 = quite a bit. Based on participants' responses to these questions at 2, 6, and 12 months we categorized participants into one of three sleep disturbance groups at each time point. These three groups represent the different potential combinations of responses to the sleep-related questions. Those who answered that they did not have a sleep problem were categorized into a no sleep problem group. Those who answered that they did have a sleep problem but that it did not impact function or only impacted function a little bit were categorized into a sleep problem with no-to-minimal-impact group. Those who answered that they did have a sleep problem and it had a moderate or quite a bit of an impact on function were categorized into a sleep problem with moderate-to-quite-a-bit-of-impact group. These were the only items in the original study related to sleep – participants were not asked about prior sleep habits, pre-existing sleep disorder diagnoses, or history of sleep problems.

The Stroke Impact Scale was also administered at 2, 6, and 12 months post stroke and available for our analysis here. The Stroke Impact Scale is a self-report measure of health-related quality of life after stroke.[23,24] It was designed with input from people who had experienced a stroke and their caregivers and consists of eight subscales: limb strength, memory and thinking, emotion, communication, activities of daily living (ADL independence), mobility, hand function, and participation. The Stroke Impact Scale also contains one question where patients/clients rate their overall recovery on a scale from 0 to 100, where 100 represents full recovery. The Stroke Impact Scale is a valid and reliable measure of health-related quality of life after stroke, with higher scores representing better function.[23–26]

Data analysis

Descriptive statistics were used to describe the characteristics of the sample (age, gender, stroke location, and stroke type at baseline; and modified Rankin Scale, and motor Fugl-Meyer at two months post stroke). All participants who answered the sleep-related questions at each time point were included in our analyses. Data were analyzed cross-sectionally, because no data on self-reported sleep problems were available at baseline, and the questionnaire was administered at the three different time points (2, 6, and 12 months post stroke). Initially, we performed a Kolmogorov–Smimov test to examine the normality of the Stroke Impact Scale data at 2, 6, and 12 months post stroke. These results indicated that the data was not normally distributed. Because the data were not normally distributed we used a series of Kruskal–Wallis tests (at each time point) to determine if there were any differences in Stroke Impact Scale subscale scores among participants in the three groups (those who reported no sleep problems, those who reported sleep problems with no-to-minimal-impact on function, and those who reported sleep problems with moderate-to-quite-a-bit impact on function at 2, 6, and 12months post stroke). Alpha was set at <0.05. If the Kruskal–Wallis test indicated a difference among groups we used a Mann–Whitney 17-test to examine were the difference was, with the alpha corrected to <0.01667 for multiple comparisons. In addition, to determine if the type of intervention received had an impact on the outcomes, we used a chi-squared test to determine if the proportion of participants in the three Locomotor Experience Applied Post-Stroke intervention groups (i.e. those who received early locomotor training with body weight support, those who participated in a home exercise program, and those who received late locomotor training with body weight support) was equal among the three sleep disturbance groups at each time point (i.e. 2, 6, and 12 months post stroke).

Results

Complete data from 408 participants were available at two months post stroke; mean age was 62.0years (12.7), 55% (224/408) were males, median modified Rankin Scale was 3.0 (range of 3), and mean motor Fugl-Meyer score was 58.3 (25.3). Eighty percent (327/408) had an ischemic stroke, 19% (76/408) had a hemorrhagic stroke, and in 1% (5/408) the type of stroke was unknown. Forty-eight percent (197/408) had a right hemisphere stroke, 35% (143/408) had a left hemisphere stroke, 15.2% had a brainstem stroke, and 2% (6/208) had a bilateral stroke. The numbers of data points for analyses dropped slightly for subsequent time points, resulting in n=380 at six months and n=360 at 12 months, due to incomplete data.

The presence and impact of sleep problems on function reported by participants remained approximately steady across the three time points. That is, the proportion of study participants reporting no sleep problems at 2, 6, and 12months was 76% (310/408), 75%, (286/380), and 77% (277/360), respectively. The proportion reporting a sleep problem with no-to-minimal-impact on function at 2, 6, and 12months was 16% (64/408), 17% (63/380), and 14% (52/360), respectively. And, the proportion of participants reporting sleep problems with moderate-to-quite-a-bit-of-impact on function at 2, 6, and 12months was 8% (34/408), 8% (31/380), and 9% (31/360), respectively.

The self-reported impact of sleep problems on health-related quality of life at 2, 6, and 12 months post stroke is summarized in Table 1 for each of the Stroke Impact Scale subscales. At two months post stroke the Kruskal–Wallis test found differences among sleep problem groups in these Stroke Impact Scale subscales: activities of daily living, mobility, emotion, limb strength, and hand function ($P < 0.05$). There was no difference among groups in the Stroke Impact Scale subscales for participation, full recovery, memory, and communication ($P \geqslant 0.05$). Post hoc analyses using the Mann–Whitney U-test found a difference between the no sleep problem and moderate-to-quite-a-bit sleep problem groups in the Stroke Impact Scale subscales for activities of daily living, mobility, emotion, and hand function ($P < 0.017$).

At six months post stroke the Kruskal–Wallis test found a difference among sleep problem groups in the Stroke Impact Scale subscales for activities of daily living, mobility, participation, emotion, limb strength, memory, and communication ($P < 0.05$). There was no difference among sleep problem groups in the Stroke Impact Scale subscales for full recovery and hand function ($P \geqslant 0.05$). Post hoc analyses using the Mann–Whitney U-test found a difference between the no sleep problem and moderate-to-quite-a-bit sleep problem groups in the Stroke Impact Scale subscales for mobility, participation, emotion, memory, and communication ($P < 0.017$); and a difference between the no-to-minimal sleep problem and moderate-to-quite-a-bit sleep problem groups in the Stroke Impact Scale subscales for activities of daily living, mobility, participation, emotion, memory, and communication, see Table 1.

At 12 months post stroke the Kruskal–Wallis test found a difference among sleep problem groups in the Stroke Impact Scale subscales for activities of daily living, mobility, participation, emotion, limb strength, memory, and communication ($P < 0.05$). There was no difference among sleep problem groups in the Stroke Impact Scale subscales for full recovery and hand function ($P \geqslant 0.05$). Post hoc analyses using the Mann–Whitney U-test found a difference between the no sleep problem and moderate-to-quite-a-bit sleep problem groups in the Stroke Impact Scale subscales for mobility, emotion, and memory ($P < 0.017$); and a difference between the no-to-minimal sleep problem and moderate-to-quite-a-bit sleep disturbance groups in the Stroke Impact Scale subscales for activities of daily living, mobility, limb strength, memory, and communication.

The chi-squared analysis found that the proportion of participants in the three different Locomotor Experience Applied Post-Stroke intervention groups (i.e. those who received early locomotor training with body weight support, those who participated in a home exercise program, and those who received late locomotor training with body weight support) was equal between the three sleep problem groups (no sleep problem, sleep problem with no-to-minimal-impact on function, and sleep problem with moderate-to-quite-a-bit-of-impact on function at each time point (i.e. 2, 6, and 12months post stroke, $P \geqslant 0.05$).

Discussion

Our findings here indicate that sleep problems may degrade health-related quality of life, function, and participation during the subacute and chronic stages of post stroke recovery.

For example, participants who reported having a "sleep problem such as insomnia" that impacted their function had lower scores for (i.e. worse function in) strength, memory and thinking, mood and ability to control emotions, communication, activities of daily living ability, mobility, hand function, and participation during the first year after stroke. Mobility may also be widely affected as it was worse at 2, 6, and 12 months post stroke for individuals with more severe sleep problems. The cross-sectional nature of our analysis prevent concluding a cause-effect relationship between poor sleep and poor stroke outcomes, however, the results presented here show further exploration is warranted. Further, these results indicate that therapists may have access to sleep as an important clinical tool during post-stroke recovery, to improve quality of sleep and thus overall health-related quality of life, and potentially to improve post-stroke recovery.

The importance of sleep for brain and physiological function cannot be underestimated, as indicated by the data supporting recommendations for healthy amounts of sleep,[27,28] and adds support to the need for further work in the stroke-sleep arena. Our findings support that effects of sleep problems during stroke recovery are clinically relevant. For example, the difference in mobility outcome found here (>5 points, at 2, 6, and 12 months post stroke) is above what has been previously reported to be the minimal clinically important difference for that subscale.[29] This was also true for ADL outcome (>6 point difference),[29] and limb strength outcome (>10 point difference).[29] For outcomes here related to memory, emotion, communication and participation (minimal clinically important differences not available in the literature), differences associated with poor sleep exceeded 10% to 15% of the total score, which has been used by other researchers to estimate minimal clinically important change.[30–32] Sleep problems may also be indications of diagnosable sleep disorders, such as obstructive sleep apnea or insomnia disorder, both known to interfere with stroke recovery. One systematic review regarding stroke recovery and obstructive sleep apnea,[33] for example reports that people with stroke and obstructive sleep apnea exhibit higher risk for recurrent stroke and higher mortality compared to those without obstructive sleep apnea. Other studies regarding stroke recovery and insomnia report differences in balance, physical functioning, ADL performance and quality of life following stroke depending on sleep behaviors (poor vs not poor) according to DSM-IV insomnia criteria among individuals in acute rehabilitation facilities weeks post-stroke and among community-dwelling individuals several months post-stroke.[6,34–36]

There are some limitations in our study that must be considered when interpreting our results. We do not know if participants who reported "a sleep problem, such as insomnia" were subsequently assessed for sleep issues and/or diagnosed with a sleep disorder nor do we know what specific sleep disorder they may have had, or if they received treatments for their sleep problems over the course of the original study. We cannot, therefore, determine if specific sleep disorders have different impacts on health-related quality of life. Use of broad descriptive and/or study- or author-specific questions to assess sleep, however, is a common limitation in the existing literature,[1,2,13,37] and indicates opportunities for future work to better understand the complex interplay between sleep and stroke recovery. In addition, in the original study, participants were not asked about prior sleep disorder diagnoses or prior sleep issues, thus it is not possible to determine from this analysis if stroke (i) correlates to incidence of sleep problems, (ii) worsens previously existing sleep problems, and (iii) commonly co-exists with sleep problems because of common risk factors, or if observations result from some combination of the above. Further, our choice to analyze the data in a cross-sectional manner might also be considered a limitation, as this method obviates the ability to predict if sleep problems early after stroke could have had a negative impact later in recovery. This was done, as noted in the earlier Data Analysis section, because no data on self-reported sleep problems were available at baseline, and the questionnaire was administered at the three different time points (2, 6, and 12 months post stroke). The impact of self-reported sleep problems may have changed in individual participants across time.

There are several implications of the present study. First, physical therapists may be able to include simple approaches to improving or preventing sleep problems as means for improving health-related quality of life following stroke. For example, encouraging patients to attend to sleep hygiene, such as blocking ambient noise and light via earplugs and eye masks[38] or avoiding caffeine and exercise near bedtime[39] can lead to improved sleep quality and therefore improved overall quality of life. Second, if patient-reported sleep problems lead to additional follow-up regarding sleep disorders, and if sleep disorders such as obstructive sleep apnea and insomnia disorder are diagnosed by a physician or other sleep specialist, physical therapists may be able to play important roles in treating the sleep disorders by adding behavioral therapies to the usual course of post stroke rehabilitation. Such behavioral therapies for sleep disorders might be as simple as encouraging adherence to nightly therapy for obstructive sleep apnea (continuous positive airway pressure masks) or as complex as cognitive behavioral therapy for insomnia disorder. Treating sleep disorders in this way could circumvent poor stroke recovery outcomes that would have been associated with poor sleep caused by sleep apnea or insomnia. It may also be beneficial to further define “sleep problems” following stroke within the context specific sleep disorder diagnoses, including obstructive sleep disorder, insomnia disorder, restless legs syndrome, and others (e.g. see American Academy of Sleep Medicine practice guidelines[40]). This could help identify additional sleep-related therapies to incorporate during post-stroke rehabilitation to improve the overall trajectory of recovery.

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Clinical messages

- Twenty-five percent of people with stroke report sleep difficulty and 10% report that it negatively impacts their function.
- Individuals with stroke who report sleep problems have worse function and health related quality of life outcomes.
- Worsening of function with increased sleep difficulties was observed at 2, 6, and 12 months post-stroke.

Table 1.

Impact of self-reported sleep problem on health-related quality of life at 2, 6, and 12 months post stroke.

Stroke Impact Scale subscale	Time since stroke								
	Two months			Six months			12 months		
	Sleep problem group (see key)			Sleep problem group (see key)			Sleep problem group (see key)		
	NSP[a] (*n* = 310)	SP-NMI[b] (*n* = 64)	SP-MQBI[c] (*n* = 34)	NSP[a] (*n* = 286)	SP-NMI[b] (*n* = 63)	SP-MQBI[c] (*n* = 31)	NSP[a] (*n* = 277)	SP-NMI[b] (*n* = 52)	SP-MQBI[c] (*n* = 31)
	Median (interquartile range)								
Limb strength	43.7 *	37.5 *	37.5 *	50.0 *	43.7 *	43.7 *	50.0 *	62.5 *¥	43.7 *
	(31.2–56.2)	(25.0–56.2)	(25.0–50.0)	(37.5–68.7)	(25.0–62.5)	(25.0–56.2)	(31.2–68.7)	(31.2–67.2)	(25.0–56.2)
Memory	87.5	89.3	78.6	89.3 *†	89.3 *¥	67.9 *	89.3 *†	89.3 *¥	75.0 *
	(71.4–100.0)	(75.0–96.4)	(56.2–93.7)	(71.4–100.0)	(75.0–100.0)	(53.6–82.1)	(71.4–100.0)	(71.4–96.4)	(57.1–89.3)
Emotion	83.3 *†	77.8 *	66.7 *	83.3 *†	83.3 *¥	75.0 *	83.3 *†	79.2 *	72.2 *
	(67.4–91.7)	(61.1–88.9)	(54.7–81.2)	(72.2–94.4)	(66.7–91.7)	(52.8–83.3)	(69.4–91.7)	(63.9–91.7)	(38.9–88.9)
Communication	92.8	96.4	85.7	92.8 *†	96.4 *¥	82.1 *	92.9 *	96.4 *¥	78.6 *
	(78.6–100.0)	(78.6–100.0)	(58.9–100.0)	(78.6–100.0)	(82.1–100.0)	(57.1–92.9)	(78.6–100.0)	(85.7–100.0)	(64.3–100.0)
Activities of daily living	55.0 *†	51.2 *	45.0 *	65.0 *	72.5 *¥	62.5 *	67.5 *	72.5 *¥	55.0 *
	(42.5–70.0)	(37.5–67.5)	(27.5–60.0)	(50.0–80.0)	(57.5–85.0)	(40.0–75.0)	(52.5–82.5)	(60.6–86.9)	(42.5–75)
Mobility	61.1 *†	56.9 *	47.2 *	75.0 *†	77.8 *¥	63.9 *	77.8 *†	80.6 *¥	66.7 *
	(47.7–75.0)	(44.4–72.2)	(35.4–63.9)	(60.4–75.0)	(63.9–88.9)	(47.2–77.8)	(61.1–88.9)	(69.4–91.0)	(47.2–75.0)
Hand function	15.0 *†	12.5 *	0.0 *	30.0	45.0	10.0	30.0	47.5	15.0
	(0.0–45.0)	(0.0–40.0)	(0.0–20.0)	(0.0–65.0)	(0.0–75.0)	(0.0–60.0)	(0.0–65.0)	(1.2–80.0)	(0.0–55.0)
Participation	43.7	35.9	40.6	59.4 *†	65.6 *¥	43.7 *†	59.4 *	65.6 *	53.1 *
	(31.2–62.5)	(21.9–56.2)	(21.9–54.7)	(40.6–75.0)	(40.6–81.2)	(28.1–59.4)	(40.6–81.2)	(50.0–86.7)	(31.2–68.7)
Full recovery	50.0	40.0	40.0	60.0	60.0	55.0	60.0	70.0	50.0
	(30.0–61.2)	(25.0–60.0)	(37.5–50.0)	(40.0–70.0)	(40.0–70.0)	(40.0–70.0)	(50.0–80.0)	(50.0–80.0)	(40.0–75.0)

Key:

[a] NSP – no sleep problem.

[b] SP-NMI – sleep problem with no-to-minlmal-lmpact on function.

[c]SP-MQBI – sleep problem with moderate-or-quite-a-bit-of-lmpact on function (*reference group*).

[*]Difference in function among the sleep groups per Kruskal-Wallis test ($P < 0.05$).

[†]Difference in function between individuals with no sleep problem (NSP) and sleep problem that causes moderate-or-quite-a-bit-of-impact on function (SP-MQBI) per post-hoc Mann-Whitney *U*-test ($P < 0.017$).

[¥]Difference in function between individuals with sleep problem that causes no-to-minimal-impact on function (SP-NMI) and those with sleep problem that causes moderate- or-quite-a-bit-of-impact on function (SP-MQBI) per post-hoc Mann-Whitney *U*-test ($P < 0.017$).