JCSM
Journal of Clinical Sleep Medicine

SCIENTIFIC INVESTIGATIONS

Prevalence, Effect on Functional Outcome, and Treatment of Sleep-Disordered Breathing in Patients With Subacute Stroke

Daisuke Matsuura, MD[1]; Yohei Otaka, MD, PhD[1,2,3]; Rie Kamigaichi, MD, MPH[1]; Kaoru Honaga, MD, PhD[1]; Kunitsugu Kondo, MD, PhD[1]; Meigen Liu, MD, PhD[2]

[1]*Department of Rehabilitation Medicine, Tokyo Bay Rehabilitation Hospital, Chiba, Japan;* [2]*Department of Rehabilitation Medicine, Keio University School of Medicine, Tokyo, Japan;* [3]*Department of Rehabilitation Medicine I, School of Medicine, Fujita Health University, Aichi, Japan*

Study Objectives: We aimed to elucidate the prevalence of sleep-disordered breathing (SDB), effect of SDB severity on the functional outcome, and feasibility of continuous positive airway pressure (CPAP) therapy in patients with subacute stroke.

Methods: We recruited 433 consecutive patients (mean age: 66.5 years, 271 men) admitted to our rehabilitation wards for subacute stroke (8 to 90 days after onset) from August 2011–November 2013, who had undergone at least one successful sleep study within 4 weeks after admission to the wards. We investigated the prevalence of SDB, defined as a respiratory event index (REI) ≥ 5 events/h; the relationship between SDB severity and the functional outcome at discharge; and the number of patients receiving and adhering to CPAP therapy.

Results: REIs ≥ 5 and ≥ 15 events/h were observed for 87.3% (n = 378) and 46.4% (n = 201) of patients, respectively. The Functional Independence Measure score at discharge was significantly lower for patients with REI ≥ 15 events/h than for those with REI < 15 events/h. However, REI was not an independent factor for functional outcome after adjustment for potential confounders, irrespective of stroke types. CPAP therapy was administered to 41 patients (9.5%). During the mean follow-up period of 21.6 months, 20 patients (48.8%) dropped out from the CPAP therapy. Among the 23 patients who continued CPAP therapy until discharge, 17 (74%) continued its use throughout the follow-up period or discontinued therapy because of improvement.

Conclusions: SDB prevalence was high in patients with subacute stroke at admission. However, SDB severity was not significantly related to functional outcome at discharge. Although the overall adherence was not good, relatively good adherence to CPAP therapy after discharge was observed when CPAP was successfully introduced during hospitalization.

Keywords: cerebrovascular disorders, comorbidity, continuous positive airway pressure, convalescent hospital, rehabilitation, sleep apnea syndrome, sleep disorders

Citation: Matsuura D, Otaka Y, Kamigaichi R, Honaga K, MD, Kondo K, Liu M. Prevalence, effect on functional outcome, and treatment of sleep-disordered breathing in patients with subacute stroke. *J Clin Sleep Med.* 2019;15(6):891–897.

BRIEF SUMMARY

Current Knowledge/Study Rationale: Sleep-disordered breathing (SDB) is an important issue associated with subacute stroke. We investigated its prevalence and the effect of its severity on the functional outcome and feasibility of continuous positive airway pressure (CPAP) therapy in actual clinical settings.

Study Impact: Our results suggest that SDB is very common in patients with subacute stroke. Its severity exhibits an association with the severity of motor dysfunction and disability, although it is not an independent factor for the functional outcome. The high SDB prevalence and relatively good adherence to CPAP therapy after discharge suggests that appropriate SDB evaluation and CPAP administration during hospitalization is recommended to alleviate SDB-related symptoms and improve the health-related quality of life in patients who have experienced subacute stroke.

INTRODUCTION

Sleep-disordered breathing (SDB) leads to sleep fragmentation and intermittent hypoxia and is a known independent risk factor for stroke.[1,2] Furthermore, SDB is frequently observed in patients with stroke,[3] not only in the acute phase but also in the subacute phase.[4-9]

However, previous studies on the prevalence and treatment of SDB and its relationship with functional outcomes in patients with subacute stroke are subject to several limitations, including relatively small samples (n < 100)[6,8,9] and the inclusion of patients with only ischemic stroke[7] or a very small percentage of patients with hemorrhagic stroke (approximately 10%).[4,5] Furthermore, although there have been several reports regarding the effects of SDB on functional outcome in patients with subacute stroke,[6,8-12] the findings have been inconsistent. Some studies have reported that SDB severity is associated with poor functional outcomes[6,10,11] and prolonged hospitalization.[6] However, others have concluded that there is no association between SDB and functional outcomes.[8,9,12] As stated, the sample sizes of these reports have been small (n < 100), and they lacked adjustment for important confounders such as the functional status at admission.[6,8-12] In addition, some studies only used the oxyhemoglobin desaturation for the detection of SDB.[10-12] Furthermore, the feasibility of using current recommended clinical treatments such as continuous positive airway pressure (CPAP) therapy in clinical settings has not been thoroughly examined. Only one previous study investigated this issue in a very small sample.[13]

Therefore, knowledge of SDB in patients with subacute stroke is still lacking. In the current study, we aimed to determine (1) the prevalence of SDB, (2) effect of SDB severity on functional outcome, and (3) feasibility of CPAP therapy in a large number of patients with subacute stroke, including hemorrhagic stroke.

METHODS

Participants

We retrospectively analyzed data for 785 consecutive patients admitted with subacute stroke admitted to our rehabilitation wards between August 2011 and November 2013. Each patient was examined by computed tomography or magnetic resonance imaging to confirm the diagnosis of stroke (ischemic stroke, intracerebral hemorrhage, or subarachnoid hemorrhage). In accordance with a previous report, we defined the subacute phase as 8 to 90 days after onset.[14] Patients were included in the analyses if a sleep evaluation was successfully performed within 90 days from stroke onset and 4 weeks of admission to the rehabilitation wards. The local ethics committee approved the study protocol (#52-2), which was in accordance with the 2013 revision of the Declaration of Helsinki of 1964.

SDB Evaluation

We evaluated the presence of SDB in consecutive patients admitted to our rehabilitation wards. Among the 785 patients, we excluded those who did not agree to receive sleep evaluation or could not tolerate evaluation because of unstable medical conditions, as well as those using nasogastric tube feeding, transferred to another hospital, or discharged before sleep evaluation.

Evaluation was performed with a portable sleep monitor device (Smart Watch PMP-300E, Pacific Medico, Tokyo, Japan) classified as $C_4O_{1x}P_2E_4R_2$ according to the Sleep, Cardiovascular, Oximetry, Position, Effort, and Respiratory (SCOPER) out-of-center testing classification.[15] We assessed nasal ventilation using a nasal cannula connected to a pressure transducer, while body movements, including breathing, were assessed using a sensor attached to a thoracoabdominal belt. The degree of oxygen saturation was measured using a sensor attached to the participant's fingertip. Snoring and body posture were also recorded. We defined apnea as the absence of airflow or a ≥ 90% decrease in airflow from baseline for at least 10 seconds. Hypopnea was defined as a ≥ 50% decrease in ventilatory signals for at least 10 seconds, with a simultaneous decrease in SpO_2 of at least 3%. We defined the respiratory event index (REI) as the number of respiratory events (ie, apneas or hypopneas) documented per hour of recording. Apneas were classified as obstructive or central in the presence or absence of thoracoabdominal motion, respectively. Obstructive sleep apnea was diagnosed when ≥ 50% apneas were of the obstructive type, whereas central sleep apnea was diagnosed when > 50% apneas were of the central type. Patients with REI ≥ 5 events/h received a diagnosis of SDB, and those with a REI ≥ 15 events/h received a diagnosis of moderate to severe SDB. Finally, we assessed daytime sleepiness using the Epworth Sleepiness Scale (ESS)[16] just before the sleep evaluation.

An REI < 40 events/h is lower than the REI criteria defined for receiving CPAP therapy under insurance coverage in Japan. In order to determine indications for CPAP therapy for patients with an REI < 40 events/h and ≥ 15 events/h and/or the presence of sleep disorder symptoms such as excessive sleepiness, snoring, and arousal response during sleep, standard polysomnography (PSG) was performed using the Alice LE (Pacific Medico, Tokyo, Japan) when the patient agreed to undergo the test as per the physician's recommendation. PSG included two-channel electroencephalography, chin and leg electromyography, and electrooculography in addition to airflow assessment, pulse oximetry, and thoracic and abdominal belts.

CPAP Therapy

The Japanese national health insurance covers CPAP therapy when patients have an REI ≥ 40 events/h as per a portable sleep monitor or an apnea-hypopnea index (AHI) ≥ 20 events/h as per standard PSG. Patients were prescribed treatment with CPAP (REMstar Auto System One Series, Philips Respironics, GK, Tokyo, Japan) when they met the insurance criteria, were willing to receive treatment, and received support from their physicians regarding the indications for CPAP therapy.

Initially, the physician set the device, including mask fitting and pressure adjustments. Subsequently, nurses performed routine settings and adjustments if patients needed assistance while using the CPAP device. Good adherence was defined as 4 hours or more of CPAP usage per night and an REI ≤ 5 events/h. To accomplish good adherence, we initially introduced CPAP for a short period and gradually increased the duration with careful titration.

Data Collection

We recorded background information, including age, sex, type of stroke, duration from stroke onset, body mass index (BMI), past history of stroke, side of motor paresis, and presence of infratentorial lesions. We assessed motor function using the Stroke Impairment Assessment Set (SIAS), which has high validity and reliability.[17,18] If motor paresis was bilateral, we used the scores for the weaker limb. We also assessed activities of daily living using the Functional Independence Measure (FIM)[19] at admission and discharge.

Statistical Analyses

First, we analyzed the distribution of REI scores to assess the prevalence and severity of SDB. Second, we divided the patients into two groups according to the recommended criteria of the American Academy of Sleep Medicine[20]: REI ≥ 15 events/h, and REI < 15 events/h. Subsequently, we compared the characteristics and functional outcomes between the two groups and examined their associations with SDB. For continuous variables, we used the unpaired t-test or Wilcoxon rank-sum test depending on the scale and distribution. To compare categorical variables, we used the chi-square test or Fisher exact test.

Third, we built a multiple regression model for the FIM score at discharge and examined the effects of SDB at admission on the outcomes at discharge. In addition to REI at admission, we included the following covariates that are potentially or known to be related to the functional outcome at discharge[21,22]: age, degree of paresis, FIM score at admission, length of stay in the rehabilitation unit, duration from onset to admission, past history of stroke, and type of stroke. Furthermore, we included the interaction terms (REI × stroke type) in the regression model to determine any differences in the effect of SDB on the functional outcome among the different types of stroke. Finally, we identified the number of patients receiving CPAP and explored the treatment adherence.

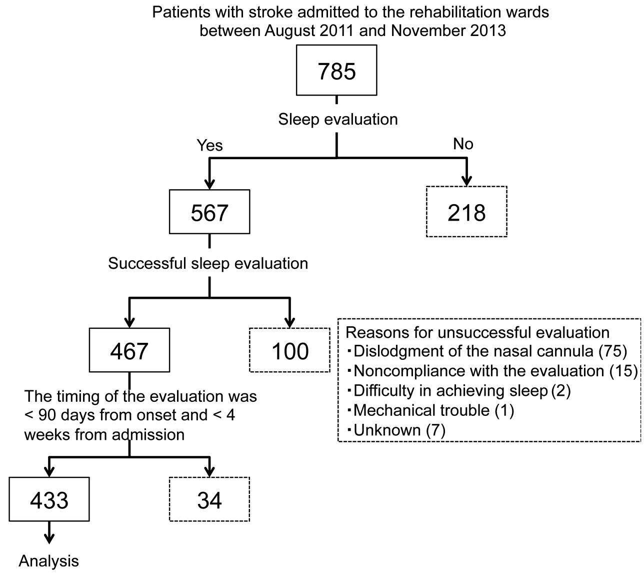
All statistical analyses were performed using STATA SE13.1 (StataCorp., College Station, Texas, United States). A value of $P < .05$ was considered statistically significant.

RESULTS

Participant Characteristics

SDB evaluation was performed for 567 of the 785 patients. A total of 100 patients (17.6%) experienced technical failures; the failure rates were 19.5% (62/318), 15.4% (32/208), and 14.6% (6/41) for ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage, respectively. Of the 467 patients with at least one successful sleep study, 433 (mean age: 66.5 years; men, n = 271) underwent the study within 90 days of onset and 4 weeks of admission; these were included in our analyses. **Figure 1** and **Table 1** present the flow and characteristics of participants, respectively.

Figure 1—Flow of screening for sleep-disordered breathing in patients with subacute stroke.



Among the 785 consecutive patients with stroke who were admitted to the rehabilitation wards, 433 were included in the analyses.

REI Distribution

The mean (standard deviation [SD]) REI for the 433 patients was 17.2 (12.5) events/h. **Figure 2** shows the proportion of patients with each REI category (REI ≥ 5 events/h, 87.3%, n = 378; REI ≥ 10 events/h, 65.1%, n = 282; REI ≥ 15 events/h, 46.4%, n = 201; REI ≥ 20 events/h, 33.9%, n = 147; REI ≥ 30 events/h, 14.8%, n = 64; and REI ≥ 40 events/h, 7.6%, n = 33). Among those with REI ≥ 5 events/h (n = 378), 90.2% (n = 341) exhibited obstructive apnea and 9.8% (n = 37) exhibited central apnea. Similarly, among patients with REI ≥ 15 events/h (n = 201), 90.1% (n = 181) exhibited obstructive apnea and 9.9% (n = 20) exhibited central apnea. In 23 patients who received full PSG, the mean (SD) REI measured by the portable sleep monitor was 24.1 (7.5) events/h and that measured by PSG was 35.9 (12.9) events/h. Spearman rho for the correlation between REI and AHI was 0.54 ($P = .008$).

Comparisons According to REI

Comparisons of characteristics between patients with REI ≥ 15 events/h and those with REI < 15 events/h are shown in **Table 1**. Patients with REI ≥ 15 were significantly older and more likely to be male than were patients with REI < 15 events/h. Moreover, patients with REI ≥ 15 events/h had a significantly greater BMI than did patients with REI < 15 events/h. However, only seven patients (3.5%) with REI ≥ 15 events/h exhibited a BMI in the obesity range (BMI ≥ 30 kg/m^2). The median ESS score for patients with REI ≥ 15 events/h was 4 and tended to be higher than that in patients with REI < 15 events/h. However, only 9 patients (4.6%) presented with excessive daytime sleepiness (ESS score ≥ 11).

There were no significant differences between the groups with regard to the type of stroke, past history of stroke, and presence of supra/infratentorial lesions. The severity of hemiparesis evaluated using the motor scores of SIAS was significantly worse for both the upper and lower extremities in patients with REI ≥ 15 events/h than in those with REI < 15 events/h. Patients with REI ≥ 15 events/h exhibited significantly lower median FIM scores at admission and discharge than did those with REI < 15 events/h (75 versus 89 at admission, $P < .001$; 111 versus 116 at discharge, $P < .001$).

Relationship Between REI and Functional Outcomes

In multiple regression analysis, the REI × stroke type interaction terms were not significant ($P > .05$), suggesting that the effect of SDB on functional outcome was not significantly different among stroke types. After exclusion of the interaction terms because of the lack of significance, multiple regression analysis adjusted for age, sex, past history of stroke, type of stroke, degree of paresis, duration from onset to admission, length of hospital stay, and FIM score at admission suggested that the REI value was not significantly related to the FIM score at discharge (**Table 2**). Furthermore, this finding was maintained even when patients who received CPAP were excluded from the model (n = 397, β for REI = 0.005, $P = .887$).

CPAP Therapy Pathway

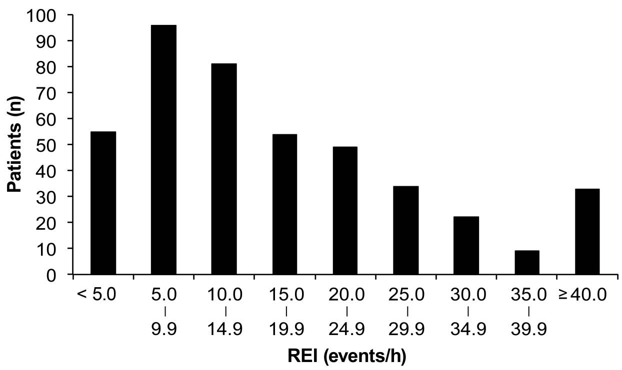
Figure 3 shows the pathway after CPAP introduction. CPAP was introduced for 41 patients (36 patients during hospitalization, 5 patients after discharge). The mean (SD) REI measured

Table 1—Participant characteristics and comparisons between patients with REI < 15 events/h and those with REI ≥ 15 events/h.

Variables	All Participants (n = 433)	REI < 15 events/h (n = 232)	REI ≥ 15 events/h (n = 201)	*P*
Age (years)	66.5 ± 12.5	64.2 ± 13.1	69.3 ± 11.2	< .001
Male/female	271/162	127/105	144/57	< .001
BMI (kg/m^2)	22.3 ± 3.4	21.7 ± 3.0	22.9 ± 3.6	< .001
Obesity, BMI ≥ 30 kg/m^2, n (%)	9 (2.1)	2 (0.9)	7 (3.5)	.057
Epworth Sleepiness Scale score*	4 [1–6]	3 [1–5]	4 [2–7]	.089
Epworth Sleepiness Scale score ≥ 11, n (%)*	22 (5.2)	13 (5.8)	9 (4.6)	.555
Type of stroke				.898 (.894)
Ischemic stroke, n (%) (lacunar/atherothrombotic/cardioembolic/other)	239 (40/116/58/25)	129 (54.0) (20/65/30/14)	110 (46.0) (20/51/28/11)	
Intracerebral hemorrhage, n (%)	164	86 (52.4)	78 (47.6)	
Subarachnoid hemorrhage, n (%)	30	17 (56.7)	13 (43.3)	
Past history of stroke, n (%)	66 (15.2)	32 (13.8)	34 (16.9)	.367
Infratentorial lesions, n (%)	83 (19.2)	42 (18.1)	41 (20.4)	.545
Duration of stroke onset to admission (days)	35.8 ± 12.9	36.0 ± 12.9	35.6 ± 12.9	.788
Duration of admission to sleep evaluation (days)	11.4 ± 4.7	11.3 ± 4.4	11.6 ± 5.0	.497
SIAS motor at admission				
Knee-mouth test	4 [2–4]	4 [2–5]	4 [1–4]	.006
Finger function test	4 [1–4]	4 [1–4]	3 [1–4]	.026
Hip flexion test	4 [2–4]	4 [2–5]	3 [2–4]	.003
Knee extension test	4 [2–4]	4 [2–5]	3 [2–4]	.002
Foot-pat test	4 [1–4]	4 [1–5]	3 [1–4]	.014
FIM				
Admission				
Motor score	55 [25–73]	60 [43-76]	49 [34-65]	< .001
Cognitive score	28 [21–32]	29 [23-33]	28 [21-32]	.091
Total	82 [62–103]	89 [69–106]	75 [59–96]	< .001
Discharge				
Motor score	82 [71–88]	84 [75.5-89]	81 [67-87]	< .001
Cognitive score	32 [27–35]	33 [28–35]	31 [26–35]	.008
Total	114 [101–121]	116 [105–122]	111 [95–119]	< .001
Length of hospital stay (days)	86.9 ± 45.7	83.6 ± 48.9	90.7 ± 41.5	.101

Values are presented as number (percentage), mean ± standard deviation, or median [interquartile rage]. * = data missing for 12 patients (9 with REI < 15 events/h, three with REI ≥ 15 events/h). BMI = body mass index, FIM = Functional Independence Measure, REI = respiratory event index, SIAS = Stroke Impairment Assessment Set.

Figure 2—Distribution of the REI in patients with subacute stroke.



Approximately 90% of patients showed at least mild sleep-disordered breathing (REI ≥ 5 events/h). The peak of distribution was at an REI of 5.0–9.9 events/h. REI = respiratory event index.

by the portable sleep monitor was 34.2 (12.8) events/h. Twelve patients stopped using CPAP during hospitalization, whereas treatment was discontinued for one patient because of marked improvement in REI. At discharge, CPAP therapy was continued for 23 patients (63.9% of those who had received CPAP therapy during hospitalization). Twenty-eight patients, including five who were introduced to CPAP therapy after discharge, were followed up in outpatient clinics. Of these, eight stopped using CPAP, whereas it was discontinued for one patient because of REI improvement. Overall, CPAP therapy was continued for 19 patients (46.3%) and discontinued for two following an improvement during the mean follow-up period of 21.6 months. The rate of good adherence to CPAP therapy (≥ 4 hours per night for ≥ 70% nights, REI < 5 events/h) was 89.5% (17 patients). In total, 20 patients (48.8%) did not adhere to CPAP therapy and stopped the treatment. However, most patients who continued CPAP therapy until discharge from the

Table 2—Multiple regression analysis for variables predicting the total FIM score at discharge (n = 433).

Variable	β	Coefficient	SE	*t*	*P*
REI	0.02	0.03	0.05	0.64	.522
Age	−0.11	−0.19	0.06	−3.20	.001
Male	0.00	0.01	1.30	0.01	.992
Body mass index	0.40	0.24	0.20	1.24	.214
Total SIAS motor score	0.11	0.28	0.12	2.35	.019
Total FIM score at admission	0.71	0.57	0.04	14.55	< .001
Past history of stroke	−0.06	−3.30	1.71	−1.91	.057
Type of stroke (reference: ischemic stroke)					
Intracerebral hemorrhage	0.00	0.13	1.34	0.10	.923
Subarachnoid hemorrhage	0.04	3.35	2.74	1.23	.221
Duration from onset to admission, days	−0.11	−0.18	0.05	−3.46	.001
Length of hospital stay, days	0.13	0.06	0.02	3.01	.003
Constant		64.50	8.16	7.90	< .001

$F_{11, 421}$ = 67.30, P < .001, R^2 = .638, adjusted R^2 = .628. FIM = Functional Independence Measure, REI = respiratory event index, SE = standard error, SIAS = Stroke Impairment Assessment Set.

hospital continued (74%), and only six (26%) did not adhere to it until the end of the follow-up period (**Figure 3**).

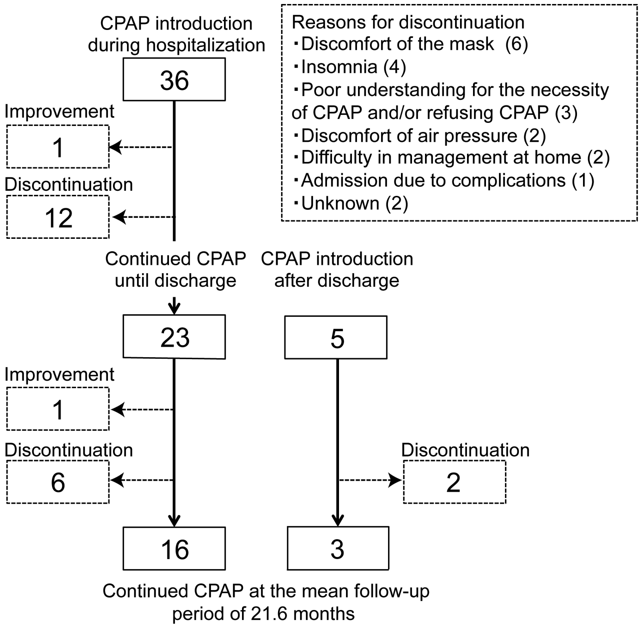
DISCUSSION

In this study, we investigated the prevalence of SDB, influence of SDB on the functional outcome, and introduction of CPAP therapy and its adherence in a large number of patients with subacute stroke, including hemorrhagic stroke. To the best of our knowledge, this study included the largest sample reported thus far.

In a meta-analysis of 2,343 patients with stroke and transient ischemic attack, the prevalence of SDB (defined as AHI ≥ 5) was 72%.[3] The prevalence of SDB (defined by REI ≥ 5 events/h) in our sample was 87.2%. Collectively these findings suggest that SDB is very common and one of the major comorbidities in patients with stroke. One strength of our study was that 164 patients with hemorrhagic stroke were also included in the sample. The number of such patients was much larger than that in the sample of the meta-analysis, which included only 87 patients with hemorrhagic stroke among the total of 2,343 patients. In this study, we observed no difference in the SDB rates among the different stroke types (**Table 1**).

In patients with stroke, it has been reported that self-reported symptoms such as daytime sleepiness are vague and do not accurately indicate SDB.[23,24] Furthermore, it is known that BMI of patients with stroke is relatively lower than that of healthy community-dwelling individuals, among whom there is a similar severity of SDB.[23] In our study, patients with REI ≥ 15 events/h had higher ESS and BMI than did patients with REI < 15 events/h. However, the differences were small, and the proportions of obese patients (BMI ≥ 30 kg/m^2) and those with excessive sleepiness (ESS score ≥ 11) were less than 5% (**Table 1**). This indicates that screening for self-reported symptoms and/or BMI is insufficient for SDB detection in patients with stroke. Taking the high prevalence of SDB among

Figure 3—Patient flow through induction and adherence to CPAP therapy.



CPAP was introduced for 41 patients, including 5 who received the therapy after discharge. Overall, CPAP was continued in 19 patients and discontinued in 2 following an improvement at the mean follow-up period of 21.6 months. CPAP = continuous positive airway pressure.

patients with stroke, it is ideal to evaluate every patient's sleep using a portable sleep monitor device and/or PSG. However, considering that only 10% of those screened with a sleep study eventually received CPAP therapy in the current study, further investigations are required to seek an appropriate sleep evaluation method for this population in terms of the cost effectiveness.

Findings regarding the association between SDB and functional outcomes in patients with subacute stroke have been inconsistent.[6,8-12] In addition, studies have recruited relatively small samples[6,8-12] and implemented poor methodology to detect SDB.[10-12] This had made it difficult to draw any certain conclusions before the current study. In the current study, hemiparesis was significantly severe, and we observed significantly lower FIM scores at admission in patients with moderate to severe SDB (REI ≥ 15 events/h) than in those with REI < 15 events/h. We also observed significantly lower FIM scores at discharge in patients with REI ≥ 15 events/h. However, our multivariate analysis suggested that REI was not an independent explanatory variable for the FIM score at discharge after adjustment for several influential factors, including the FIM score at admission. These findings indicate that SDB following stroke is influenced by the severity of motor dysfunction and disability, and decreased ability to perform activities of daily living at discharge in patients with SDB appear to be mainly caused by these factors, which act as confounders of the relationship between SDB and functional outcomes.

As stated previously, our study suggested that the severity of motor dysfunction and disability in stroke is related to the severity of SDB. There are two possible explanations for this finding. It has been reported that patients with acute stroke and with severe disability spend a greater percentage of their sleep time in the supine position, which may be associated with increased AHI.[25] The other possible explanation is that oropharyngeal weakness might exist depending on the severity of motor dysfunction. Furthermore, the combination of these two factors may threaten airway patency in patients with stroke.

Consistent with the rules for Japanese national insurance (AHI ≥ 20 events/h indicated by PSG and/or REI ≥ 40 events/h as per a portable sleep monitor), CPAP was introduced for approximately 10% of patients who underwent a sleep study. In addition, 26 patients (63.4% of those who received CPAP) received CPAP after PSG because the results of the portable sleep monitor did not satisfy the criteria for insurance coverage. Considering that more patients were eligible for CPAP after PSG, clinicians in subacute rehabilitation hospitals should bear in mind that there may be a large number of patients with SDB that is severe enough to require CPAP therapy.

With regard to adherence to CPAP therapy in patients with subacute stroke, Sandberg et al. reported that the treatment was used for less than 4 hours in 16 of 31 patients with newly administered CPAP therapy.[26] Aaronson et al. reported that CPAP was used for an average of 2.5 hours per night for 20 patients, and only 7 patients showed good adherence (> 4 hours per night).[27] In our study, the overall adherence rate was poor, and approximately half the patients stopped using CPAP therapy. However, if CPAP was successfully continued during hospitalization, subsequent adherence was relatively good after discharge. Furthermore, approximately 90% of patients who continued with CPAP therapy until the end of the follow-up period showed good adherence (≥ 4 hours per night for ≥ 70% nights, REI < 5 events/h).

There are two possible reasons for the overall low adherence rate for CPAP treatment in the current study. First, most patients with SDB did not show excessive sleepiness. As opposed to community-dwelling individuals with sleep apnea syndrome who visit a hospital with symptoms, patients with subacute stroke may be less motivated for CPAP therapy because of the lack of self-reported symptoms. Second, patients often were unable to use CPAP independently because of various impairments following stroke. These characteristics of patients after stroke may prevent the continuation of CPAP therapy. Palombini et al. highlighted that education and support of patients and families and special training sessions in rehabilitation services are needed to overcome these challenges.[28] Our results suggest that adherence to CPAP therapy after discharge was good. Although this was possibly caused by dropout from the CPAP therapy of patients with poor adherence before discharge, we believe that our efforts to educate patients and their families and resolve problems affecting the continuation of CPAP therapy during hospitalization were required to obtain this level of adherence after discharge. In subacute inpatient rehabilitation, especially in Japan, there is sufficient time to introduce CPAP, with appropriate education and adjustments for any challenges to its use. Considering that many patients drop out in the early phase of CPAP introduction, stroke inpatient rehabilitation provides a great opportunity to introduce treatment for SDB.

Our study is subject to some limitations. First, SDB was evaluated using a portable sleep monitor. Although in our study there was a moderate correlation with the results of the full PSG and many previous studies have investigated SDB with this type of device,[3] it is possible that we underestimated the SDB rate. Second, this study was conducted at a single facility. Although the participants were consecutively included, any generalizations should be cautiously made. Third, we excluded 27.8% patients who could not undergo the sleep study because of unstable medical conditions, nasogastric tube feeding, and so on. This also reduces the generalizability of the current findings to the whole stroke population. Finally, we assessed the outcome with the FIM score at discharge from the hospital. We did not investigate longer-term outcomes. Further study with a longer follow-up period is needed to reveal how SDB during the subacute phase and therapeutic intervention affect the long-term outcomes, including mortality.

CONCLUSIONS

Our results suggest that the prevalence of SDB in patients with subacute stroke was very high. SDB was related to the severity of motor dysfunction and disability; however, the SDB severity itself was not independently associated with the rehabilitation outcome. Considering the high prevalence of SDB in patients with subacute stroke and the relatively good adherence to CPAP therapy after discharge, we recommend clinicians to ensure appropriate evaluation of SDB and introduce CPAP therapy during hospitalization for patients with subacute stroke in order to alleviate SDB-related symptoms and improve the health-related quality of life.[29]

ABBREVIATIONS

AHI, apnea-hypopnea index
BMI, body mass index

CPAP, continuous positive airway pressure
ESS, Epworth Sleepiness Scale
FIM, Functional Independence Measure
PSG, polysomnography
REI, respiratory event index
SDB, sleep-disordered breathing
SIAS, Stroke Impairment Assessment Set

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ACKNOWLEDGMENTS

The authors thank Sayuri Kashiwagi and Miwa Noguchi for their support with the sleep studies. Author contributions: D. Matsuura contributed to study concept; design, collection, analysis, and interpretation of the data; and manuscript writing. Y. Otaka contributed to study concept and design, data analysis and interpretation, and manuscript editing. R. Kamigaichi contributed to collection and interpretation of the data and manuscript editing. K. Honaga, K. Kondo, and M. Liu contributed to interpretation of the data and manuscript editing. All authors participated in discussion of the results and critical revision of the manuscript.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication November 8, 2018
Submitted in final revised form February 22, 2019
Accepted for publication February 25, 2019
Address correspondence to: Yohei Otaka, MD, PhD, Department of Rehabilitation Medicine I, School of Medicine, Fujita Health University, 1-98 Dengakugakubo, Kutsukake, Toyoake, Aichi 470-1192, Japan; Tel: +81-562-93-2167; Fax: +81-562-95-2906; Email: otaka119@mac.com

DISCLOSURE STATEMENT

All authors have seen and approved the manuscript. Work for this study was performed at the Department of Rehabilitation Medicine, Tokyo Bay Rehabilitation Hospital, Chiba, Japan. The authors report no conflicts of interest.