Original article

# Quality of sleep in stroke patients at Phramongkutklao Hospital

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*Background:* Stroke is one of the leading causes of death and serious long-term disability worldwide. A common consequence of stroke is reduced quality of sleep.
*Objective:* To study the quality of sleep in patients with stroke, related factors and the compatibility of wearable tracker device for collecting sleep data.
*Methods:* This cross-sectional study included 66 subjects with stroke at Phramongkutklao Hospital using questionnaires including demographic questions, sleep quality assessment (PSQI), and the satisfaction of Wearable tracker tool assessments. Each subject received a wearable tracker to examine the sleep quality.
*Results:* According to the PSQI assessment, the majority of subjects had poor sleep quality or insomnia (93.9%). Factors related to sleep quality included level of education, sleep range, time to go bed time after 12:00 am, waking time during 4:00 am - 06:00 am, and deep sleep time, duration of stroke suffering for more than 1 week, and use of antidiabetic drugs. According to the use of wearable tracker tool, total sleep duration and deep sleep duration were significantly correlated with PSQI, and the acceptability of the device was good.
*Conclusion:* The majority of the subjects had poor sleep quality. Factors related to sleep quality included both personal factors and illness factors. Additionally, the wearable tracker tool showed the possibility to measure the sleep activity accurately and was acceptable by the patients. These findings could help clinician to examine the quality of sleep in patients with stroke.

*Keywords:* Quality of sleep, stroke, wearable tracker.

Cerebrovascular disease or stroke is a major public health problem of the world's population. In Thailand, the Ministry of Public Health reported that prevalence of stroke was approximately 77.4 per 100,000. [1] In 2005, stroke was found to be the third leading cause of death in Thailand.

Patients with stoke were affected physically, psychologically and economically. Abnormal sleep was also impacted and consequently reduced patients' quality of life. Poor sleep quality could be presented as morning sleepiness and, in the end, would lead to declined performance. Moreover, heart disease, cancer and hypertension were associated with this condition.[2]

There were a number of studies assessing the quality of sleep in patients with stroke. The widely used measurement to examine sleep quality and related factors was Pittsburgh Sleep Quality Index (PSQI).[3] Other methods to evaluate sleep quality included sleep test, oxygen saturation and electrical activity in brain or muscle. One of reliable and acceptable tools to assess sleep quality was the wearable tracker.[4] It was a computer-based intelligent activity measuring device that synced data and illustrated in graph. However, this device has not been used popularly, in order to measure sleep quality among patients with stroke, especially in Thailand.

Tang WK, *et al.* [5] found that the prevalence of insomnia was 44.0% in patients with stroke and resulted in irritability and undesirable behavior. Lunka W, *et al.* [6] also reported the same prevalence and found that etiology of stroke, depression and sleep hygiene were associated with insomnia in 106 stroke patients.

According to the study sleep quality in stroke at Phamongkutklao Hospital, Thailand, the aim of study was to study the quality of sleep in stroke patients and study the use of measuring devices, activities to collect sleep data in patients with stroke at Phramongkutklao Hospital. The result in this study may be used to concern about sleep quality in stroke and the use of device in another study.

## Materials and methods
### Subjects

In this descriptive study, we examined patients with stroke at Phramongkutklao Hospital. The study recruited inpatients and outpatients of the physical therapy department and stroke unit whose diagnosis of stroke was given by specialist physician. The inclusion criteria included patients aged 20 years and over, be able to communicate in Thai, and neurological examination showed good conscious level. The exclusion criteria was patients who had weakness in both sides of upper extremities, and those with conditions such as dementia, or skin diseases affecting the area around the wrist. The study has been approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University (IRB no.308/62), and the Committee of Research Ethics, Phramongkutklao Hospital.

This study recruited 66 subjects. Sample size was calculated from study of incidence and types of sleep disorders in patients with stroke with power of 0.8 and type I error at 0.05.

### Procedures

Between January and April 2020, patients who met inclusion criteria were invited. A written informed consent form was obtained from each subject. Assessment questionnaires were given to patients and their clinical data were collected from medical record. After that, the subjects were asked to apply a wearable tracker for 3 consecutive nights to record their sleep patterns. The result then was analyzed by statistical method.

### Measurements

Each subject was collected demographic and clinical data including age, gender, marital and educational status, type of stroke and current medication.

A translated version of The Pittsburgh Sleep Quality Index (PSQI) was used in this study. The PSQI consisted of seven sections: sleep quality, duration of sleep, duration from bedtime to sleep, normally disrupted sleep, and the use of sleeping pills and its effects. Sleep quality was calculated based on the total score of the seven of the four compositions, which were in the range of 0 - 21 points. The total score less than or equal to 5 points reflected good sleep quality, and the total score greater than 5 showed poor sleep quality. Sensitivity and specificity of PSQI were 89.6% and 86.5% respectively.[3]

Wearable tracker device was the commercial, watch-like, instrument. Its weight was 8.5 gram and 17.9 x 46.9 x 12 mm in size. This thermoplastic device was comfortably applied to subject's dominant wrist or non-weakness side, in case of the dominant side was weak. Total sleep time, deep and light sleep duration, time awake, fall asleep and wake up time were offline recorded for 3 consecutive nights.

### Statistical analysis

Data analysis and statistics inference was submitted to SPSS Version 22. Information from demographic and clinical questionnaires, PSQI and wearable tracker device was described in average, proportion, percentage, frequency and standard deviation (SD). Further univariate and multiple regression were used to analyze the factors associated with sleep quality. Additionally, data obtained from the wearable device and acceptability to the device were examined. A $P$ - value of less than 0.05 was considered statistically significant.

## Results

Sixty-six subjects were successfully recruited; demographic data, age, gender clinical data are illustrated (Table 1).

Of 66 subjects, 62 (93.9%) had poor sleep quality, measured from the PSQI. The mean PSQI score was 10.6 (SD = 3.6). The quality of sleep of the subjects classified by the components of sleep showed that most of them had a poor quality of sleep; 56.1% of the subjects spent 31 - 60 minutes from bedtime to actual sleep (sleep latency); 46.9% had the duration of sleep each night for more than 7 hours; 74.2% had a slight disturbance of sleep (1 - 9 points) and 80.3% rarely used sleeping pills. Daytime dysfunction was found 39.4% both in no (0 points) and slight problem (1 - 2 points) (Figure 1).

**Table 1.** Demographic and clinical data of subjects (n = 66).

| Demographic data | Number | Percentage |
|---|---|---|
| **Age** (years) (mean = 63.1, SD = 1.8 : min = 23, max = 95) | | |
|     < 50 | 10 | 15.2 |
|     51 - 60 | 17 | 25.8 |
|     61 - 70 | 21 | 31.8 |
|     > 70 | 18 | 27.2 |
| **Gender** | | |
|     Male | 48 | 72.7 |
|     Female | 18 | 27.3 |
| **Marital status** | | |
|     Single | 13 | 19.7 |
|     Marriage | 48 | 72.7 |
|     Divorce | 5 | 7.6 |
| **Educational** | | |
|     No formal education | 1 | 1.5 |
|     Less than high school | 9 | 13.6 |
|     High school/high vocational | 15 | 22.7 |
|     Associate degree | 13 | 19.7 |
|     Bachelor's degree | 22 | 33.3 |
|     Higher than Bachelor's degree | 6 | 9.1 |
| **Occupational** | | |
|     Retire/Unemployed | 26 | 39.4 |
|     Government | 25 | 37.9 |
|     State-owner enterprise | 2 | 3.0 |
|     Office employee | 1 | 1.5 |
|     Personal business | 5 | 7.6 |
|     Vendor | 1 | 1.5 |
|     Freelance/employee | 5 | 7.6 |
|     Student | 1 | 1.5 |
| **Ward** | | |
|     IPD | 47 | 71.2 |
|     OPD | 19 | 28.8 |
| **Psychiatric illness** | | |
|     Major depressive disorder | 3 | 4.5 |
|     Anxiety disorder | 1 | 1.5 |
|     Insomnia disorder | 1 | 1.5 |
|     Mood disorder, unspecify | 1 | 1.5 |
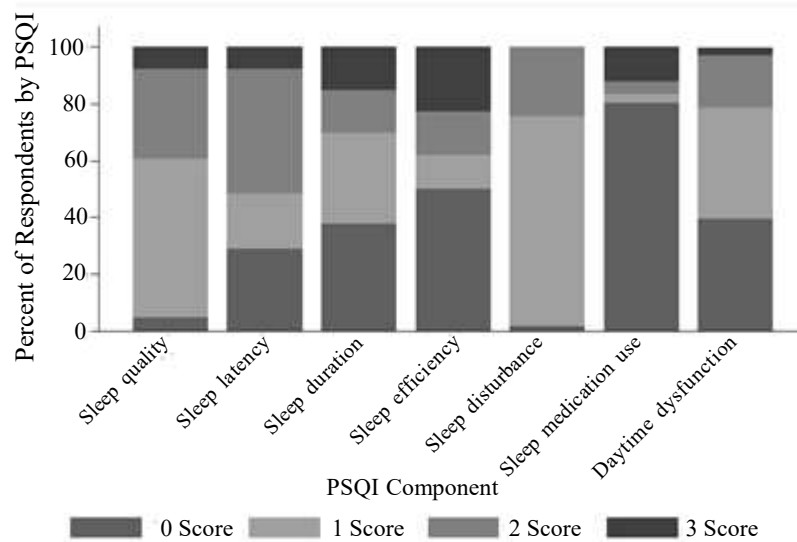
**Figure 1.** Percentage of sleep quality in the samples classified by the components of sleep from the sleep quality assessment form (PSQI).

Parameters obtained from wearable tracker devices, including total and deep sleep time, showed significant correlation with sleep quality. However, fall asleep time, wake up time, light sleep duration and time awake were not significantly correlated with the PSQI score (Table 2).

Univariate analysis showed association between sleep quality and education of Bachelor's degree or higher, total sleep time, fall asleep time later than 12:00 am. and wake up time, categorized by data distribution, between 04:00 am - 06:00 am. (Table 3).

Multiple regression analysis revealed that only duration of stroke more than 1 week was statistically associated with sleep quality (Table 4).

Figure 1. The quality of sleep in the samples classified by the components of sleep found that Most of the subjects had a good quality of sleep. 56.1% of the time spent sleeping from bedtime to sleep during the period 31 - 60 minutes, 46.9% had the duration of sleep each night for more than 7 hours. Normal sleep is more effective than normal sleep. More than 85.0%, 50.0% have a slight disturbance of sleep (1 - 9 points) 74.2%, rarely use sleeping pills 80.3% and the results affecting the activities during the day is not a problem at all (0 points) and a slight problem (1 - 2 points) 39.4% equally.

**Table 2.** Analysis of the relationship between sleep data obtained from wearable tracker activity measurement and PSQI scores.

| Quality of sleep (PSQI) | r | 95%CI | P - value |
|---|---|---|---|
| Total sleep time (hour) | - 0.291 | (- 0.502 to - 0.046) | 0.021* |
| Fall asleep time (time) | 0.234 | (- 0.014 to 0.456) | 0.065 |
| Wake up time (time) | - 0.219 | (- 0.443 to 0.031) | 0.085 |
| Deep Sleep time (minutes) | - 0.261 | (- 0.478 to - 0.014) | 0.039* |
| Light Sleep time (minutes) | - 0.234 | (- 0.456 to 0.014) | 0.064 |
| Time awake (minutes) | - 0.042 | (- 0.286 to 0.208) | 0.746 |

*$P < 0.05$

**Table 3.** Results of univariate analysis of factors affected sleep quality (PSQI).

| Variables | B | S.E.B | β | t | P-value | R² |
|---|---|---|---|---|---|---|
| **Education** | | | | | | |
| Highschool/vocational | -2.000 | 1.392 | -0.235 | -1.44 | 0.156 | 0.1414 |
| Associate degree | -2.585 | 1.435 | -0.288 | -1.8 | 0.076 | |
| Bachelor's degree or higher | -3.879 | 1.256 | -0.537 | -3.09 | 0.003** | |
| **Career** | | | | | | |
| Unstable income | 0.426 | 1.255 | 0.046 | 0.34 | 0.735 | 0.0187 |
| No income | 1.074 | 0.984 | 0.148 | 1.09 | 0.279 | |
| **Total sleep time (hours)** | -0.468 | 0.197 | -0.291 | -2.37 | 0.021* | 0.0846 |
| **Fall asleep time** | | | | | | |
| 10:00 pm - 00:00 am. | 1.067 | 1.095 | 0.147 | 0.97 | 0.334 | 0.1029 |
| More than 00:00 am. | 3.267 | 1.284 | 0.384 | 2.54 | 0.014* | |
| **Wakeup time** | | | | | | |
| 04:00 am. - 06:00 am. | -2.750 | 1.056 | -0.379 | -2.6 | 0.012* | 0.1110 |
| More than 06:00 am. | -2.655 | 1.240 | -0.312 | -2.14 | 0.036 | |
| **Deep sleep time (minutes)** | -0.016 | 0.007 | -0.0261 | -2.11 | 0.039* | 0.0681 |
| **Type of stroke** | | | | | | |
| Hemorrhagic stroke | -0.659 | 1.088 | -0.076 | -0.61 | 0.547 | 0.0057 |
| Duration more than 1 week | 1.886 | 0.861 | 0.264 | 2.19 | 0.032* | 0.0698 |
| **Medication use** | | | | | | |
| Antiplatelet | -0.791 | 0.893 | -0.110 | -0.89 | 0.379 | 0.0121 |
| Antihyperlipidemic | -0.774 | 0.922 | -0.104 | -0.84 | 0.404 | 0.0109 |
| Benzodiazepine | 0.313 | 1.019 | 0.038 | 0.31 | 0.759 | 0.0015 |
| Antidepressants | 4.031 | 2.552 | 0.194 | 1.58 | 0.119 | 0.0375 |
| Antihistamine | -1.199 | 1.291 | -0.115 | -0.93 | 0.356 | 0.0133 |
| Antihypertensive | -0.848 | 0.906 | -0.116 | -0.94 | 0.353 | 0.0135 |
| Antidiabetic | -5.766 | 2.500 | -0.277 | -2.31 | 0.024* | 0.0768 |
| Anticonvulsive | -0.094 | 2.601 | -0.005 | -0.04 | 0.971 | <0.0001 |

*P < 0.05, **P < 0.01

**Table 4.** Results of multiple linear regression analysis of factors affected sleep quality (PSQI).

| Variable factor | Multivariable analysis | | | | |
|---|---|---|---|---|---|
| | B | S.E.B | β | t | P-value |
| **Education** | | | | | |
| High school/High vocational | -0.371 | 1.861 | -0.042 | -0.20 | 0.842 |
| Associate degree | -1.964 | 1.874 | -0.219 | -1.05 | 0.299 |
| Bachelor's degree or higher | -2.148 | 1.695 | 0.293 | -1.27 | 0.211 |
| Stroke duration more than 1 week | 1.958 | 0.890 | 0.270 | 2.20 | 0.032* |
| Antidiabetic use | -4.522 | 2.801 | -0.218 | -1.61 | 0.113 |
| Total sleep time (hours) | -0.001 | 0.006 | -0.051 | -0.20 | 0.843 |
| **Fall asleep time** | | | | | |
| 22:00 pm - 00:00 am. | 0.406 | 1.319 | 0.056 | 0.31 | 0.759 |
| More than 00:00 am. | 2.197 | 2.135 | 0.258 | 1.03 | 0.308 |
| **Wakeup time** | | | | | |
| 04:00 am. - 06:00 am. | 0.083 | 1.593 | 0.011 | 0.05 | 0.958 |
| More than 06:00 am. | -0.286 | 2.225 | -0.033 | -0.13 | 0.898 |
| Deep sleep time (minutes) | 0.002 | 0.011 | 0.048 | 0.25 | 0.800 |

*P < 0.05

## Discussion

### Quality of sleep in stroke patients at Phramongkutklao Hospital

This study found that the majority of patients with stroke at Phramongkutklao Hospital had poor sleep quality (62/66, 93.9%), which was consistent with Lungka W, et al. [6] that studied the relationship between the types of stroke, depression, sleep hygiene and insomnia of 106 stroke patients, found that 45.3% of the patients had insomnia. Kim J, et al. [7] found that 53.0% of patients with stroke had insomnia. Tang WK, et al. [5] found that 44.0% of stroke patients had insomnia which resulted in undesirable behavior and irritable mood. The adverse reactions caused reduction in interaction with people or the surrounding environment. In summary, sleep problem in patients with stroke was very common.

### Factors related to sleep quality

Although various factors were associated with PSQI score in univariate analysis. Only duration of stroke was still statistically significant in multiple regression analysis. According to Phramongkutklao hospital service, acute stroke was defined as duration of stroke less than 1 week. This factor was associated with poorer sleep quality scores which was consistent with the study of Palomäki H, et al. [8] The study found that longer period of hospitalization in patients with stroke and depression was associated with lower insomnia rate. The authors explained that longer period of hospitalization allowed patients to gain more knowledge to take care of themselves and more support from healthcare professionals. However Leppavouri A, et al. [9] studied insomnia in ischemic stroke patients and found that stroke duration of 3 - 4 months was associated with more frequent insomnia. In addition, Rocha D, et al. [10] found association between insomnia and more than 12 months duration of stroke. However, the discrepancy in these results might be due to the differences in population and settings where data were collected.

Education level was significantly associated with sleep quality in our multiple regression analysis. Our finding was consistent with a previous study. Rocha D, et al. [10] reported that education was not associated with sleep quality in stroke patients. However, the current study observed a trend of association between higher education and better sleep quality in univariate analysis, but the study might not have sufficient power to maintain statistical significance in multiple regression. Individual who are highly educated might be more adaptive to cope with sleep problem.

Antidiabetic use was associated with sleep quality, inconsistent with the study of Tangsirikul N, et al. [11] The author studied sleep quality of elderly with type 2 diabetes, and found no correlation of medication and sleep quality.

Sleep chronologic parameters, including total sleep time, fall asleep time, wakeup time and deep sleep duration, were not associated with PSQI score. Although, total sleep time and deep sleep duration showed significant correlations with PSQI in univariate analysis. Our findings were consistent with previous studies of Buysse DJ, et al. [12] and Kaplan K, et al. [13] The previous studies reported that chronologic data collected from polysomnography, a gold standard of sleep measurement, were not correlated with subjective sleep report, including the PSQI. Although, some studies reported association between these parameters and sleep quality in certain population Bsatien CH, et al. [14], Campos TF, et al. [13] Small degree of association might explain the current study's non-significant findings.

### The use of wearable tracker in sleep data collection in stroke patients at Phramongkutklao Hospital

The wearable tracker could be used to measure the sleep parameter and report useful information including total sleep time, bedtime, wake up time and deep sleep duration. There were correlation between sleep quality with statistically significant, which consistent with a previous study Gruwez A, et al. [16] The study showed good validity of two commercially-available sleep trackers and actigraphy for assessment of sleep parameters in obstructive sleep apnea patients that found wearable sleep monitors that have been provided a good estimation of time in bed and light sleep.

## Conclusion

The results of this study showed that the majority of patients with stroke at Phramongkutklao Hospital had poor sleep quality. The factors associated with sleep quality included education level, total sleep time, time going to bed later than 12:00 am, waking time during 04:00 am - 06:00 am, deep sleep (minutes), the use of antidiabetic medication and more than 1 week of stroke incident. Further, parameters measured from

wearable tracker device were correlated with sleep quality score. This study revealed the magnitude of sleep problem among patients with stroke, and the possibility of using wearable tracker device for monitoring sleep in this patient group. This studies can be obtained from the research can be applied to the screening quality. Able to sleep in stroke patients to find ways
to promote sleep quality in this group of patients.

## Acknowledgements

## Conflict of interest
The authors, hereby, declare no conflict of interest.

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