Disorders of Sleep and Wake in Patients After Subarachnoid Hemorrhage

Wouter J. Schuiling, MD; Gabriël J.E. Rinkel, MD; Rob Walchenbach, MD; Al W. de Weerd, MD

Background and Purpose—To determine the frequency and severity of disorders of sleep and wake and their relation to the quality of life (QoL) in patients who have survived an episode of subarachnoid hemorrhage (SAH).

Methods—In a prospectively collected, consecutive series of 89 patients, 83 patients completed validated and frequently used questionnaires for the assessment of disorders of sleep and wake (SDL and Epworth Sleepiness Score) at least 1 year (range, 1 to 3.4 years) after the SAH. We used the modified Rankin scale for functional outcome and Short Form 36 (SF-36) to assess QoL. We related the occurrence of severe problems with sleep (insomnia or excessive daytime sleepiness score or both ≥3 on SDL) to functional outcome and to the QoL scores and compared the latter scores with data from a Dutch reference population. In a subset of 20 patients with severe problems with sleep, we performed polysomnographic and actigraphic studies at home during 48 hours.

Results—Twenty eight (34%) patients had severe problems with sleep. Frequently reported problems are initiating (25%) or maintaining (31%) sleep, difficulty returning (28%) asleep, tiredness (31%), and excessive sleepiness during the day (6%). QoL was considerably reduced in patients with severe problems with sleep. During the sleep monitoring studies, severe sleep fragmentation, sleep apnea, restless legs syndrome/periodic limb movement disorder, or a combination of these disorders of sleep and wake occurred in 19 of 20 patients.

Conclusion—Many patients who have survived an episode of SAH have disorders of sleep and wake, which are related to the QoL. (Stroke. 2005;36:578-582.)

Key Words: outcome ■ quality of life ■ sleep ■ subarachnoid hemorrhage

Many patients who have survived an episode of subarachnoid hemorrhage (SAH) remain dependent in performing activities in daily living, and many of those who are independent have a reduced quality of life (QoL). The reasons for this reduction in QoL have not yet been determined. During long-term follow-up, patients who have had an SAH frequently report lack of initiative, falling asleep during daily activities, fatigue, irritability, loss of interests, and lack of concentration. Similar problems during daytime are often seen in patients with disorders of sleep and wake. The reported problems in patients with SAH may therefore be related to sleep disturbances. Disturbed sleep is a common symptom after an ischemic stroke but has never been investigated among SAH patients. The major sleep disorder associated with ischemic stroke is sleep apnea (OSAS), but insomnia and excessive daytime sleepiness (EDS) are frequently found after ischemic stroke as well. These sleep disturbances affect QoL, and treatment of these disorders of sleep and wake can improve QoL.

We performed a survey of the frequency and severity of specific sleep disturbances in patients who have survived an episode of SAH. Additionally, we investigated the relation between sleep disturbances or excessive daytime sleepiness and the QoL at least 1 year after SAH.

Patients and Methods

We studied a prospectively collected series of consecutive patients with SAH who had been admitted to the Medical Center Haaglanden in The Hague between January 1, 2000 and December 1, 2002. All patients had extravasated blood in the basal cisterns on computed tomography (CT) or, if CT was negative, xanthochromia of the cerebrospinal fluid. Patients with a nonaneurysmal perimesencephalic hemorrhage (distribution of blood mainly or exclusively around the mesencephalon and no aneurysm on 4 vessel angiography) were included but those with SAH of traumatic origin or bleeding from a vascular malformation were excluded. The clinical condition on admission was assessed by means of the World Federation of Neurological Surgeons (WFNS) scale. A dichotomy was made between good (WFNS I, II, or III) and poor neurological condition (WFNS IV of V). The amount of subarachnoid blood on CT was assessed according to the classification of Hijdra. The amount of blood in 10 cisterns or fissures and in 4 ventricles on CT was graded separately on a semi-quantitative scale ranging from 0 (no blood visible) to 3 (completely filled with blood). The sum scores of cisternal blood (range, 0 to 30) and of ventricular blood (range, 0 to 12) were dichotomized at their median value.

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Measures
All patients completed the Sleep Diagnosis Questionnaire (SDL) to explore the possibility of sleep disorders. The SDL is a questionnaire with a Likert scale, with the categories “never,” “seldom,” “sometimes,” “often,” and “very often or always.” The questionnaire is derived from the Sleep Diagnostic Questionnaire.10 The Dutch translation is validated for the Netherlands in a normal population and in a patient population with sleep disorders.11 The 75 questions cover 6 dimensions of sleep (related) disorders. These dimensions are insomnia, restless legs syndrome (RLS), EDS, narcolepsy, sleep disorders caused by depression, and sleep apnea syndrome. Per dimension, a total score can be calculated from the relevant items in the questionnaire. This score ranges from 0 to 4. For our survey of the SAH patients, we focused on the dimensions insomnia and EDS. A score of $\geq 3$ on at least 1 of these 2 dimensions was considered as a significant indicator for a disorder of sleep and wake (severe sleep problems). We also used the Epworth Sleepiness Score (ESS), a frequently used subjective assessment, as a second measure for daytime sleepiness. The ESS has been validated in various groups of patients.12 The ESS is a questionnaire describing 8 situations, scored again with a Likert scale of “never,” “slight,” “moderate,” and a “high” chance of dozing during daytime. The sum of scores ranges from 0 to 24. A score $>10$ is thought to be indicative of EDS.13

We performed 48-hour polysomnographic studies at home in a subset of patients. For this part of the study, we asked all patients (except for patients in a nursing home) with a score of $\geq 3$ on the dimensions insomnia or EDS of the SDL. The ambulatory polysomnography (APSG) contained electroencephalography, submental electromyography, and recording of eye movements. Simultaneously, leg movements and airflow were measured during the nights. Standard scoring systems were used.14,15 Objective quality of sleep was monitored for an additional week by actigraphy recording as well. An actigraph has the size of a digital watch and is worn on the wrist of the subject during consecutive days and nights. It measures all activity above a certain limit.16 Actigraphic monitoring performed in the patient’s natural environment is a reliable and valid estimate of the sleep–wake status.17 Furthermore, this subset of patients completed the Dutch translation of the Beck Depression Inventory.18 In this inventory with 21 items, a crude score of $>16$ was used as indication of an accompanying depression.19 From the data obtained as described, a final diagnosis regarding sleep disorders was defined in these patients with severe problems with sleep.

For the assessment of measured sleep, the following measurements were chosen: sleep onset latency (cutoff point $\geq 30$ minutes), sleep efficiency (cutoff point $<80$%), and sleep fragmentation ($>8$ awakenings). Because the APSG was recorded during daytime as well, naps could be assessed in detail. The 1-week actigraphy provided a global insight in sleep and wake for a prolonged period of time. Other intrinsic sleep disorders such as OSAS and RLS/PLMD were diagnosed by the APSG. OSAS was diagnosed if patients had an apnea index score $\geq 10$ in combination with frequent daytime napping. The diagnosis RLS/periodic limb movement disorder (PLMD) was based on a periodic leg movement index exceeding 10 per hour and a history of RLS.

We used a modified Rankin Scale to assess functional outcome. The Rankin scale is a 6-point handicap scale that focuses on restrictions in lifestyle. A score of 0 to 3 indicates independence and a score of 4 to 5 indicates dependency.20 We assessed QoL by means of the Short Form 36 (SF-36), a reliable and validated questionnaire.21 The SF-36 measures 8 health-related domains: physical functioning, role limitations because of physical or emotional health problems, bodily pain, social functioning, general mental health, vitality, and general health perception. A single item is added to assess any change in health compared with 1 year before. The psychometric qualities of the Dutch version of the SF-36 have been tested in a random population sample.22 Additionally, we applied 2 simple questions regarding job consequences in a Likert-like scale (“Did you return to your previous work? Yes or no? Full-time or part-time?”) and recovery (“Do you feel that you have made a complete recovery from your SAH?”).

Procedure
All questionnaires were mailed to the patients at least 1 year after the SAH. Before sending these questionnaires, we had checked with the general practitioner if patients were still alive. If patients did not respond, we first sent 2 reminders. Patients with a score of $\geq 3$ on SDL dimensions insomnia or EDS were asked to participate in the ambulant registrations as described. A detailed history was taken of all patients and their bed partners who participated in the ambulant registrations, and all these patients were seen in our outpatient Center of Sleep and Wake Disorders to discuss final diagnosis and therapy.

Data Analysis
Descriptive statistics were used to report the frequency of problems with sleep and wake. To determine the relationship between sleep disturbances (insomnia or EDS, or both) and outcome according to the Rankin scale, and between sleep disturbances and the amount of blood on baseline CT, the $\chi^2$ test was used. This test was also used to study the relation between sleep disturbances and definite treatment (coiling or clipping) on the QoL. Results were expressed as odds ratios (ORs). We analyzed the SF-36 scores of our group using the Mann–Whitney $U$ test and expressed the differences with the normal data for the Netherlands in standard deviations from the mean in this reference group (age adjusted). The standard scores were presented as line graphs and allow comparisons between the study group and the reference population across the entire profile of the SF-36.21

Results
One hundred thirty patients with SAH had been admitted during the study period. Forty-one patients died in the first year after the SAH. Of the 89 patients who were still alive 1 year after the SAH, 6 did not return the questionnaires; the remaining 83 patients completed all questionnaires. The time lapsed since the SAH ranged from 1.0 to 3.4 years (mean, 1.7 years). No patient was using medication that affected sleep at the time of the study. Sixteen of the 83 patients (20%) reported a complete recovery. Forty-three (53%) of patients often reported tiredness on the SF-36 list, 9 (11%) were dependent on help for daily activities, and 42 (51%) had negative job consequences. (Table 1). Of the 6 patients who declined participation, 5 did not specify the reason for not responding; 1 was not able to complete the QoL questionnaire because of severe neurological and cognitive deficits. The functional outcome of these 6 patients was comparable to that of the other patients, according to the outpatient Rankin scores at 6 months after SAH.

Questionnaires
Of the 83 patients, 28 (34%; 95% confidence interval [CI], 23% to 44%) had severe sleep problems (Table 2). Frequent reports on individual questions of the SDL were difficulty falling asleep (25%; 95% CI, 16% to 35%), difficulty returning asleep (28%; 95% CI, 18% to 38%), and repeated awakenings (31%; 95% CI, 21% to 42%). Reports of snoring were noted in 35% (95% CI, 24% to 45%) of patients. Many patients reported poor concentration (18%; 95% CI, 10% to 27%), deficits of memory (23%; 95% CI, 14% to 32%), feeling very tired (31%; 95% CI, 21% to 42%), and having frequent daytime periods of dozing (6%; 95% CI, 1% to 11%). Four of the 7 (57%) patients with a perimesencephalic hemorrhage had severe problems with insomnia or excessive daytime sleepiness.
In the patients with no sleep disturbances, the mean SF-36 scores did not differ by $>0.5$ standard deviations from the scores of the reference population (Figure). In contrast, patients with severe sleep disturbances had a marked reduction in QoL compared with the normal population and the patients with no sleep problems. This difference was most prominent for the domains “social functioning” and “role limitations from physical or emotional problems,” but statistically significant in all dimensions ($P<0.001$ to $0.013$). The rate of sleep disturbances was similar for patients with restrictions in activities of daily living and those without (OR, 1.6; 95% CI, 0.40 to 6.6). Coiled patients had no significantly lower risk for sleep disturbances than operated patients (OR, 0.34; 95% CI, 0.09 to 1.34). The amount of cisternal or ventricular blood was not significantly related to the exis-

### TABLE 2. Prevalence of Sleep Disorders in Patients With SAH

<table>
<thead>
<tr>
<th>Individual SDL Questions*†</th>
<th>Difficulty falling asleep 21 (25%; 95% CI, 16%–35%)</th>
<th>Difficulty returning to sleep 23 (28%; 95% CI, 18%–38%)</th>
<th>Awaking to early 22 (27%; 95% CI, 22%–28%)</th>
<th>Repeated awakenings 26 (31%; 95% CI, 21%–42%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Awaking too late 20 (24%; 95% CI, 17%–32%)</td>
<td>Poor concentration 15 (18%; 95% CI, 10%–27%)</td>
<td>Deficits of memory 19 (23%; 95% CI, 14%–32%)</td>
<td>Feeling very tired 26 (31%; 95% CI, 21%–42%)</td>
</tr>
<tr>
<td></td>
<td>Sleeping with noise 17 (21%; 95% CI, 15%–28%)</td>
<td>Insomnia 23 (28%; 95% CI, 18%–38%) 7 (5%)</td>
<td>Feeling very tired 26 (31%; 95% CI, 21%–42%)</td>
<td>Snoring 29 (35%; 95% CI, 24%–45%)</td>
</tr>
<tr>
<td></td>
<td>Feeling very tired 26 (31%; 95% CI, 21%–42%)</td>
<td>EDS 7 (5.8%; 95% CI, 2%–15%)</td>
<td>EDS 7 (5.8%; 95% CI, 2%–15%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ESS§ 5 (6%; 95% CI, 1%–11%)</td>
<td></td>
<td>ESS§ 5 (6%; 95% CI, 1%–11%)</td>
<td></td>
</tr>
</tbody>
</table>

*Sleep Diagnosis Questionnaire.
†Often or very often on Likert scale.
‡Insomnia or EDS, or both; cutoff point for insomnia and EDS on SDL $>3$.
§Epworth Sleepiness Score $>10$.

EDS indicates excessive daytime sleepiness; ESS, Epworth Sleepiness Score.

Total of 83 patients.

In the patients with no sleep disturbances, the mean SF-36 scores did not differ by $>0.5$ standard deviations from the scores of the reference population (Figure). In contrast, patients with severe sleep disturbances had a marked reduction in QoL compared with the normal population and the patients with no sleep problems. This difference was most prominent for the domains “social functioning” and “role limitations from physical or emotional problems,” but statistically significant in all dimensions ($P<0.001$ to $0.013$). The rate of sleep disturbances was similar for patients with restrictions in activities of daily living and those without (OR, 1.6; 95% CI, 0.40 to 6.6). Coiled patients had no significantly lower risk for sleep disturbances than operated patients (OR, 0.34; 95% CI, 0.09 to 1.34). The amount of cisternal or ventricular blood was not significantly related to the exis-

### TABLE 1. Patient Characteristics

<table>
<thead>
<tr>
<th>Age, mean (SD)</th>
<th>53.3 (12.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>58 (70%)</td>
</tr>
<tr>
<td>Perimesencephalic hemorrhage</td>
<td>7 (8%)</td>
</tr>
<tr>
<td>WFNS at admission</td>
<td></td>
</tr>
<tr>
<td>I to III</td>
<td>68 (82%)</td>
</tr>
<tr>
<td>IV to V</td>
<td>15 (18%)</td>
</tr>
<tr>
<td>Hjdra score, median (range)</td>
<td></td>
</tr>
<tr>
<td>Cisternal score</td>
<td>11 (0–24)</td>
</tr>
<tr>
<td>Ventricular score</td>
<td>0 (0–12)</td>
</tr>
<tr>
<td>Aneurysm location</td>
<td></td>
</tr>
<tr>
<td>Comm ant</td>
<td>26 (31%)</td>
</tr>
<tr>
<td>ICA</td>
<td>4 (5%)</td>
</tr>
<tr>
<td>ACM</td>
<td>16 (19%)</td>
</tr>
<tr>
<td>Comm post</td>
<td>11 (13%)</td>
</tr>
<tr>
<td>VBA</td>
<td>10 (12%)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>7 (8%)</td>
</tr>
<tr>
<td>Perimesencephalic</td>
<td></td>
</tr>
<tr>
<td>Treatment of aneurysm</td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td>48 (58%)</td>
</tr>
<tr>
<td>Coiling</td>
<td>19 (23%)</td>
</tr>
<tr>
<td>Outcome</td>
<td></td>
</tr>
<tr>
<td>Rankin score</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>19 (24%)</td>
</tr>
<tr>
<td>1–3</td>
<td>54 (65%)</td>
</tr>
<tr>
<td>4–5</td>
<td>9 (11%)</td>
</tr>
<tr>
<td>Recovery (subjective)</td>
<td></td>
</tr>
<tr>
<td>Complete recovery of SAH</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>66 (80%)</td>
</tr>
<tr>
<td>Yes</td>
<td>16 (20%)</td>
</tr>
<tr>
<td>Return to previous job</td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>18 (22%)</td>
</tr>
<tr>
<td>Part-time</td>
<td>16 (19%)</td>
</tr>
<tr>
<td>No</td>
<td>26 (32%)</td>
</tr>
<tr>
<td>Not relevant*</td>
<td>22 (27%)</td>
</tr>
<tr>
<td>Do you feel tired†</td>
<td></td>
</tr>
<tr>
<td>Often or more</td>
<td>43 (53%)</td>
</tr>
<tr>
<td>Sometimes or less</td>
<td>39 (47%)</td>
</tr>
</tbody>
</table>

Total of 83 patients.

*For example, retired.
†Question in the SF-36 pertaining sleep and wake.
Comm ant indicates anterior communicant artery; ICA, internal carotid artery; MCA, middle cerebral artery; Comm post, posterior communicant artery; VBA, vertebrobasilar artery system.
Disturbed sleep initiation 7

35

SAH. In only 2 studies sleep disturbances were mentioned

disturbances in patients who have survived an episode of

QoL. Severe sleep disturbances often have considerably reduced

excessive sleepiness during the day, or both. Patients with

to 3 years after SAH. Many of these patients have insomnia,

Disorders of sleep and wake occur in one-third of patients 1

Polysomnography and actigraphy

In the 28 patients with scores 3 on the “insomnia” and

sleepiness, all of which are often mentioned by patients after

result in diminished concentration or memory, and daytime

maintenance of nighttime sleep.24 These proportions are in line

with those of our study. The sleep disturbances probably

result in diminished concentration or memory, and daytime

sleepiness, all of which are often mentioned by patients after

SAH. These consequences of poor sleep quality are related to

the QoL, which is often reduced after SAH, even in those who

are independent.23

None of these patients with APSG studies had a normal

sleep. Severe sleep fragmentation was the most frequent sleep

disturbance in these studies. Also, the frequency of significant

OSAS and severe RLS/PLMD was much higher than expected on basis of data from the general population,25,26

Both disorders can be treated. In analogy to OSAS and

RLS/PLMD in the general population, it can be expected that

therapy for these disorders may improve QoL.6,7

One of the limitations of our study is that not all patients

underwent APSG. One of the 8 patients who declined APSG

had RLS; 5 had a severely reduced SF-36 score. This reduced

QoL might have been related to sleep disturbances. Our

results therefore may be an underestimation of the actual

proportion of patients with disturbed sleep and wake. Another

limitation is that we had no control group. However, all

questionnaires we used are well-validated for normal and patient populations. We could compare the SF-36 score of our

patient group with those of an age-adjusted Dutch reference

population. Moreover, we used international standardized

scoring systems to qualify the stages of sleep and sleep-

disturbing phenomena. Although we had not systematically

acquired data on sleep before the SAH, all patients and bed

partners mentioned that the sleep disturbances had started or

worsened after the SAH. Depression might explain part of the

sleep and wake disorders, but we think that depression is not

an important cause for disturbances of sleep and wake in our

group of patients, because other aspects of sleep with depres-

sion (short REM sleep latency and increase amount of REM

sleep) were seen in only 1 of our patients. We therefore think

that in analogy to many other sleep disorders, the sleep

disturbance initiates the depression and not vice versa.27

This study may have important implications for the

follow-up of SAH patients. Sleep disorders after SAH are

very common, often serious, and are treatable. These disor-

ders are seen in patients independently of the outcome

according to the Rankin score. Our data indicate that special

attention for a sleep disorder is warranted in patients reporting

daytime fatigue, restless or nonrestorative sleep, snoring,

and RLS. Treatment of these disorders of sleep and wake may

be beneficial in patients who have survived an episode of

SAH.

Discussion

Disorders of sleep and wake occur in one-third of patients 1

to 3 years after SAH. Many of these patients have insomnia,

excessive sleepiness during the day, or both. Patients with

severe sleep disturbances often have considerably reduced

QoL.

We could not find previous systematic studies of sleep

turbances in patients who have survived an episode of

SAH. In only 2 studies sleep disturbances were mentioned

sidewise. In 1 study, as part of a self-rating scale for the QoL,

disturbed sleep was suggested in 47% of these patients.1 In a

telephone interview asking for neurological and psychosocial

outcome 4 to 7 years after SAH, 35% still experienced
daytime sleepiness or fatigue and 26% experienced problems

maintaining nighttime sleep.24 These proportions are in line

with those of our study. The sleep disturbances probably

result in diminished concentration or memory, and daytime

sleepiness, all of which are often mentioned by patients after

SAH. These consequences of poor sleep quality are related to

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Acknowledgments

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TABLE 3. Characteristics of Polysomnographic and

Actigraphic Monitoring

<table>
<thead>
<tr>
<th>Total of 20 Patients*</th>
<th>%</th>
<th>Cutoff Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep fragmentation</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;8 awakenings</td>
</tr>
<tr>
<td>Disturbed sleep init</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>iation</td>
<td></td>
<td>&gt;30 min (in at least 1 night)</td>
</tr>
<tr>
<td>Low sleep efficiency</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SEI &lt; 80%</td>
</tr>
<tr>
<td>Frequent napping</td>
<td>14</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naps during the day</td>
</tr>
<tr>
<td>OSAS</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apnea index &gt;10 and EDS</td>
</tr>
<tr>
<td>RLS/PLMD†</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Periodic leg movement index &gt;10</td>
</tr>
<tr>
<td>Inadequate sleep</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>hygiene</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Some patients had >1 symptom diagnosed.

*20 patients with severe sleep problems in SDL (insomnia or EDS, or both).

†Not scored in the OSAS patients.

SEI indicates sleep efficiency index.

QoL might have been related to sleep disturbances. Our

results therefore may be an underestimation of the actual

proportion of patients with disturbed sleep and wake. Another

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