Earplugs and eye masks vs routine care prevent sleep impairment in post-anaesthesia care unit: a randomized study

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Editor’s key points
- The biological function of sleep is the subject of discussion and debate.
- Sleep deprivation has numerous deleterious consequences.
- Factors responsible for sleep deprivation in post-anaesthesia and intensive care units include excessive light and noise.
- The effects of simple interventions on sleep quality in a post-anaesthesia care unit were studied.

Background. Post-anaesthesia care units (PACUs) with 24/7 activity and consequently artificial light and noise may disturb the sleep of patients who require prolonged medical supervision. After one postoperative night, we compared sleep quality in patients with and without noise (earplug) and light (eye mask) protection.

Methods. After ethical board approval, 46 patients without any neurological or respiratory failure undergoing major non-cardiac surgery were prospectively included. They were randomized to sleep with or without protective devices during the first postoperative night in the PACU. Sleep quality was simultaneously measured by sleep-quality scales (Spiegel score and Medical Outcomes Study Sleep), nurses’ assessment, and through a wrist actigraph (Actiwatch®). Secondary outcomes such as pain control and nocturnal activity were recorded. Comparisons between groups were made by Student’s t-test or non-parametric test for repeated measures as appropriate (SPSS 10.0). A P-value < 0.05 was considered significant.

Results. Data from 41 patients were analysed. Protective devices during the first postoperative night prevented a decrease in sleep quality compared with standard care, as evaluated by the Spiegel scale: 20 (4) vs 15 (5), P = 0.006. These devices significantly decreased the need for a nap [50% 95% confidence interval (CI) (20–80) vs 95% 95% CI (85–100), P < 0.001], but had no effect on sleep length evaluated by Actiwatch®. The total consumption of morphine was significantly reduced in the first 24 h [respectively, 15 (12) mg and 27 (17) mg, P = 0.02].

Conclusions. Earplugs and eye masks applied in the PACU during the first postoperative night significantly preserve sleep quality. Such non-invasive and cheap devices may be generalized in the PACU or in intensive care units.

Keywords: devices; postoperative care; sleep

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During the postoperative period, sleep deprivation, sleep fragmentation, and altered architecture are common.1–3 The aetiology of this impairment is multifactorial and includes postoperative pain, anxiety, residual effects of the anaesthetic agents, and an unfamiliar environment.4–5 Moreover, because of round-the-clock care activity, the intensive care unit (ICU) and post-anaesthesia care unit (PACU) environments have bright artificial lighting and are subjected to a high level of noise. Although the National Institute for Occupational Safety and Health has recommended that the noise intensity in hospitals should not exceed 35 dBA during the night and 40 dBA during the day,6 noise levels in the ICU and PACU commonly exceed these recommendations. Peak sounds louder than 80 dBA can lead to sudden arousals from sleep.7 As a consequence, sleep is fragmented, with decreased or absent slow-wave and rapid eye movement sleep.8 Observational studies have shown that at least one-third of sleep-deprived patients have symptoms consistent with the ‘ICU psychosis’ syndrome with a large anxiety component.9 Sleep deprivation and fragmentation have a deleterious effect on daytime task performance, mood, alertness, and fatigue, and can also decrease immune defences.10–11 Common causes of sleep discomfort in these units were well identified by patients and included nursing by care-givers, conversations, and noise from the vital alarms (EKG, SpO2, ventilator).12 On the other hand, previous studies have demonstrated that the implementation of guidelines to reduce noise and light levels was feasible, but this improvement was only transient and required constant compliance to succeed.13–16 Airline companies have long been offering eye masks and earplugs to improve passengers’ comfort. In healthy subjects exposed to simulated ICU noises in a sleep laboratory, these devices significantly improved subjective sleep quality and sleep architecture assessed through polysomnography.15–16 However, the environment of a sleep
laboratory during an 8 h period cannot really simulate the auditory, somatic and visual conditions experienced during the length of stay in an ICU/PACU. Therefore the assessment of sleep quality during an ICU/PACU stay should be performed on site.

The aim of the present study was to assess the effect of eye masks and earplugs, recognized as passive devices, applied to surgical patients during the first postoperative night in a PACU, on sleep quality.

Methods

This study was prospectively performed in the PACU of the Pitié-Salpêtrière Hospital, Paris, France, a 1200-bed university-based teaching hospital. It was conducted in accordance with French legislation and was approved by the local ethics committee board.

Post-anaesthesia care unit

Our PACU is an L-shaped open ward close to the operating theatres. This unit consists of 19 beds with devoted monitoring, with mechanical or non-invasive support available and a central monitoring console. It is open 24 h d<sup>−1</sup> and 7 day wk<sup>−1</sup> throughout the year. About 11 000 patients per year are admitted after scheduled or urgent surgery. The majority of patients are admitted from the operating theatre after mechanical ventilation withdrawal in the operating theatre. The usual length of stay is short, with a median of 3.2 (1.5) h, except in cases of severe co-morbidities requiring specific support, monitoring, or nursing with a consequent prolonged length of stay in the unit. The nurse ratio is 1 nurse for 2.5 patients and a physician is available at all times. Moreover, 1200 critically ill patients per year are admitted from the emergency department or from out-of-hospital areas (multitrauma patients). This latter activity peaks from 17:00 to 03:00 and contributes to disturbance of the sleep of the patients whose surgery or co-morbidities require a prolonged stay in the PACU the night after their surgery.

Methods

During the 5-month inclusion period, patients were prospectively and consecutively eligible if they had undergone a scheduled major surgery under general anaesthesia with the previous night in hospital and an expected postoperative night in the PACU related to co-morbidities or surgery. This former criterion ensured similar sleep conditions between groups. At admission and after written consent, patients filled out a questionnaire about their usual sleep as a reference [Medical Outcome Study (MOSS) scale] to diagnose possible severe sleep disorders. Exclusion criteria were bilateral deafness, blindness, severe sleep disorder requiring daily treatment and neurological disorders with shaking or cognitive preoperative dysfunction measured by mini-mental state evaluation and day-case surgery. After surgery, additional exclusion criteria were intrathecal morphine related to sedative effects and a need for postoperative non-invasive ventilation. In each group, postoperative analgesia was multimodal, and only i.v., including nefopam, except in the case of contraindication, paracetamol, and morphine with patient-controlled analgesia (PCA). In cases of re-operation or transfer to another unit during the night, the patient was excluded from the final analysis.

Randomization was performed on admission to the PACU after surgery using sealed envelopes. Patients were allocated to two different groups: the control group received routine care during the night and the intervention group received routine care plus eye mask (Sleepmasker<sup>®</sup> Schlafmaske, Stuttgart, Germany) and earplugs (Samurai<sup>®</sup> VanDeputte Group, Netherlands). Patients were encouraged by nurses to use these devices during the night without any restriction (Supplementary material, Figure S1).

Sleep quality was assessed by three different methods. First, self-assessment was performed by patients using two psychometric and validated questionnaires, the MOSS scale and the Spiegel scale<sup>18</sup> (Supplementary material, Appendix). The MOSS questionnaire consists of 12 items leading to 6 subscales or domains: sleep disturbance, sleep adequacy, daytime sleepiness, ‘supposed or known’ snoring, being awakened by shortness of breath or by a headache, and quantity of sleep. The usual MOSS scale as used to diagnose sleep disorder refers to a mean of the last 4 weeks. For this study, we twice repeated an adapted version, validated with the sleep federation, without changing any questions, but with a different temporal reference because only two nights (nights before and after surgery) were considered instead of 4 weeks. The Spiegel scale is a very simple and widely used scale with six questions about sleep. It is specifically efficient for repeated measures.<sup>18</sup> The maximum score is 30 and impaired sleep is defined as a score <24; a pathological sleep pattern exists if the score is <15. The second method for assessing sleep was an external and intermittent measurement of the patient’s sleep by a nurse with a specific chart collecting the patient’s behaviour and any external disturbing events. The third method was the wrist actigraph (Actiwatch<sup>®</sup>, Cambridge Neurotechnology Ltd, UK), an objective measure of motor activity (duration and intensity) (Supplementary material, Appendix S1). This accelerometer was placed on the non-dominant wrist at 20:00 and set to monitor movements every 5 s for a period of 12 h. Measures were stored in the device and downloaded the day after to a PC for analysis (Sleep Analysis 7<sup>®</sup>, Cambridge Neurotechnology Ltd, UK). This is a convenient tool for ambulatory recording of either limb activity or general physical activity for clinical use and research purposes<sup>19</sup> and has been validated in comparison with polysomnography.<sup>20, 21</sup> The activity plots are coupled with the specific software, serving to quantify the intensity and duration of daily physical activity. The software provides an indirect measurement of sleep duration, sleep onset latency, sleep efficiency (total time without activity during the total time of the study), activity score (times with movement during the expected interval), and sleep fragmentation (total number of periods with breaks in the sleep pattern). Finally, data were collected on nocturnal care activity, total morphine consumption during the first 24 postoperative hours through PCA, acceptance of devices, and occurrence of early delirium.
Statistical analysis

A preliminary observational study on standard care estimated that the mean nocturnal sleep time in this unit was 4 (1) h. With an expected sleeping time increase of 20%, a power of 80%, and an alpha risk of 5%, 17 patients per group were required. Because of a risk of non-adherence to the protocol estimated at 10%, a minimal number of 40 patients had to be included in the study.

All data are expressed as mean (so), median (interquartile range [IQR]) or percentage (95% CI). As appropriate, Student’s t-test or χ²-tests were performed to compare patient characteristic data between the control and the intervention groups. Non-parametric tests (MANOVA or Mann–Whitney) were used to compare the successive nights in the hospital ward and in the PACU. A per-protocol analysis was used to specifically assess the role of these devices; this analysis was then performed only on patients with the correctly assigned treatment during the study period. Statistical calculations were performed using SPSS 10.1 (SPSS, Chicago, IL, USA). A P-value < 0.05 was considered significant.

Results

Forty-six of 50 eligible patients were finally included in this randomized study while four refused consent. The main reason for prolonged stay in the PACU was major surgery with aortic repair (85%), followed by digestive surgery (oesophagectomy and surrenalecctomy) and orthopaedic repair. Male patients were predominant in both groups. Five patients were excluded from the final analysis. One patient withdrew consent the night before the surgery (group control). There was one patient with incorrectly assigned treatment in the control group. Two subjects were excluded in the treated ‘earplug’ group: one because of an emergent dialysis in another unit and the second because of an incomplete datasheet attributable to a defective actimetry record. One patient decided not to wear devices for the minimum required duration of the study (Fig. 1). Finally, 21 patients in the control group and 20 in the intervention group were included.

No difference was shown in patient characteristics (Table 1). Self-assessment was significantly different between the two groups. During the night before surgery, the quality of sleep evaluated by the Spiegel scale was the same in the two

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Inclusion factors:
50 patients approached

Withdrawal from the study: n = 4

46 randomized patients

Withdrawal from the study: n = 1

Intervention group: n = 23
Premature end: n = 1
Protocol infraction: n = 1
Incomplete datasheet: n = 1

Control group: n = 22

First postoperative night (20:00 to 08:00)
Allocation mistake: n = 1

Treated group: n = 20

Control group: n = 21

Sleep assessment: actimetry, heteroevaluation, and sleep scales

Fig 1 Flow chart of the study.
groups. The following night, the quality of sleep was unchanged in the intervention group, but significantly impaired in the control group (Fig. 2). Moreover, sleep efficiency was different between groups, with a better preservation of the quality of sleep in the intervention group than in the control group. In the latter, the impaired and pathological sleep ratio significantly increased after surgery, mainly at the expense of preserved sleep (Fig. 3).

In the intervention group, sleep disruptions evaluated with the MOSS scale were fewer [4 (1–7) vs 7 (3–10), \(P = 0.05\)] and the need for adjunctive rest above 15 min was less frequent [50% 95% CI (20–80) vs 95% 95% CI (85–100), \(P = 0.001\)] (Table 2). Nurse assessment did not show differences in sleep duration. Nevertheless, sleeping through nursing care was significantly more frequent in the intervention group than in the control group [42% 95% CI (13–71) vs 9% 95% CI (4–22), respectively, \(P = 0.03\)]. Finally, wrist actigraphs showed no difference between groups whatever the domain explored (Table 2).

Nocturnal activity, meaning either emergency admissions or nurse care (nursing, blood samples, dressing, etc.), was similar in both groups (Table 3). Postoperative disorientation was significantly different between groups, as was the consumption of opioids during the first 24 h through PCA. In the intervention group, patients used eye masks 7 h 15 min (2 h 10 min) and earplugs 6 h 40 min (1 h 45 min).

**Discussion**

Eye mask and earplug use during the first night after surgery prevented worsening in the subjective quality of sleep induced by major surgery and thus improved the quality of sleep in the PACU, decreasing the number of awakenings during care and the need for a diurnal nap. It also significantly reduced self-administered opioids.

Many studies have analysed sleep quality after surgery and anaesthesia and have identified many disruptive sleep factors. Inflammation and pain directly related to surgical stress play a central role. Anaesthesia technique (regional or general anaesthesia) does not seem to influence sleep architecture. Indeed, sleep was only partially disrupted in anaesthetized volunteers without surgery, with a reduction in the total amount of sleep. Conversely, noise is responsible for sleep disruption in healthy subjects and in-hospital patients. Environmental factors, especially noise, are prominent in sleep disorders after surgery in the PACU and ICU, whatever the patient characteristics, including age, gender, and ventilator status. Noisy stimuli in the ICU and PACU have been distinguished as those from human behaviour and those related to equipment. Indeed, patients complain first about staff talking, television, phone ringing, and then ventilator alarms with peak levels between 78 and 85 dB. As demonstrated by Kahn and colleagues, some behaviour modifications may significantly decrease the sounds that accounted for ~50% of disruptive factors. Unfortunately, behaviour-modification programmes conducted in the ICU were not systematically associated with an improvement in the patients' quality of sleep, especially when related to the

![Fig 2](https://example.com/fig2.png)

**Table 1** Patient characteristics of the population. Data are expressed as mean (SD) or median [IQR] (ASA) or percentage [95% CI]

<table>
<thead>
<tr>
<th></th>
<th>Control group (n = 21)</th>
<th>Intervention group (n = 20)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>59 (3)</td>
<td>62 (3)</td>
<td>0.45</td>
</tr>
<tr>
<td>Sex ratio (n, % of men)</td>
<td>19, 91 [78–100]</td>
<td>15, 74 [52–95]</td>
<td>0.15</td>
</tr>
<tr>
<td>Blood hypertension (n, %)</td>
<td>12, 59 [37–81]</td>
<td>14, 68 [45–91]</td>
<td>0.55</td>
</tr>
<tr>
<td>Coronary heart disease (n, %)</td>
<td>11, 50 [27–73]</td>
<td>9, 47 [22–72]</td>
<td>0.87</td>
</tr>
<tr>
<td>Diabetes mellitus (n, %)</td>
<td>2, 9 [0–22]</td>
<td>3, 15 [2–33]</td>
<td>0.53</td>
</tr>
<tr>
<td>Pathological sleep pattern (n, %)</td>
<td>2, 9 [0–22]</td>
<td>1, 4 [0–13]</td>
<td>0.58</td>
</tr>
<tr>
<td>ASA score</td>
<td>II [I–III]</td>
<td>II [I–III]</td>
<td>0.66</td>
</tr>
<tr>
<td>Preoperative use of psychotropic drugs (n, %)</td>
<td>5, 20 [9–31]</td>
<td>4, 17 [1–34]</td>
<td>0.82</td>
</tr>
<tr>
<td>Surgery (n, %)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Aortic repair</td>
<td>18, 86 [70–100]</td>
<td>17, 85 [71–100]</td>
<td>0.71</td>
</tr>
<tr>
<td>Major abdominal</td>
<td>2, 10 [2–18]</td>
<td>2, 10 [2–18]</td>
<td></td>
</tr>
<tr>
<td>Orthopaedic</td>
<td>1, 5 [1–10]</td>
<td>1, 5 [2–9]</td>
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</table>
difficulty of maintaining such a modification over a long period. Moreover, analysis showed that a real improvement in noise-preventive policy implies a decrease in the number of peak sounds, which could be difficult in the ICU/PACU because peak sounds often represent a life-threatening alarm. The installation of an acoustic alarm modulation capability could also be envisaged to adapt the intensity of these alarms to the night environment, but this suggestion appears unrealistic or even dangerous.

Thus, if it is difficult to change the patient’s environment, it may be easier to change the patient’s perception, as accomplished with simple devices such as earplugs and eye masks. These devices represent better cost-effectiveness and more feasible solutions than the reduction of peak sounds. Moreover, patients keep control over whether to remove these devices or not, and this increases their acceptance and their anxiolytic effects. This critical point of tolerance was emphasized in a review in which six subjects out of 14 rated earplugs as comfortable and 10 rated eye masks as comfortable, and all subjects used them easily and kept them on during the study nights.

Nurses’ evaluations have shown a discrepancy with patients’ self-assessment, with a declared sleep time greater than the total number of periods with breaks in the sleep pattern. Intervention group means a combination of eye masks and earplugs. Data are expressed as mean (so) or median [IQR] or percentage [95% CI].

### Table 2
Comparison of groups (intervention with a combination of earplugs and eye masks and controls) after the first postoperative night on different scales of sleep: Spiegel and MOSS scale (self-assessment), nurse assessment (heteroevaluation), and actimetry (heteroevaluation). MOSS, Medical Outcome Study Sleep scale; PACU, post-anaesthesia care unit. For actimetry, sleep efficiency means the total time without activity vs the total time of the study. Activity score is a calculation of the time with movement during the expected interval. Sleep fragmentation is the total number of periods with breaks in the sleep pattern. Intervention group means a combination of eye masks and earplugs. Data are expressed as mean (so) or median [IQR] or percentage [95% CI].

<table>
<thead>
<tr>
<th></th>
<th>Control group (n = 21)</th>
<th>Intervention group (n = 20)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autoevaluation: Spiegel and MOSS scales</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative Spiegel score</td>
<td>21 (4)</td>
<td>21 (4)</td>
<td>0.708</td>
</tr>
<tr>
<td>Postoperative Spiegel score</td>
<td>15 (5)</td>
<td>20 (4)</td>
<td>0.006</td>
</tr>
<tr>
<td>Subjective sleep latency in PACU (min)</td>
<td>46 (45)</td>
<td>31 (43)</td>
<td>0.33</td>
</tr>
<tr>
<td>Sleep time in PACU (min)</td>
<td>253 (129)</td>
<td>319 (147)</td>
<td>0.08</td>
</tr>
<tr>
<td>Feeling of disrupted sleep (%)</td>
<td>95 [86 – 100]</td>
<td>56 [30 – 81]</td>
<td>0.002</td>
</tr>
<tr>
<td>Difficulty to fall asleep (%)</td>
<td>55 [32 – 77]</td>
<td>27 [7 – 47]</td>
<td>0.07</td>
</tr>
<tr>
<td>Subjective sleep disruption (n)</td>
<td>7 [3 – 10]</td>
<td>4 [1 – 7]</td>
<td>0.05</td>
</tr>
<tr>
<td>Need for a rest (%)</td>
<td>95 [85 – 100]</td>
<td>50 [20 – 80]</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Heteroevaluation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awake duration (h)</td>
<td>3.2 (2.3)</td>
<td>3.2 (2.9)</td>
<td>0.88</td>
</tr>
<tr>
<td>Sleep duration (h)</td>
<td>5.5 (2.6)</td>
<td>6.6 (2.6)</td>
<td>0.19</td>
</tr>
<tr>
<td>Nursing without awakening patient (%)</td>
<td>9 [4 – 22]</td>
<td>42 [13 – 71]</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Actimetry</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep efficiency (%)</td>
<td>89 [85 – 92]</td>
<td>87 [82 – 93]</td>
<td>0.63</td>
</tr>
<tr>
<td>Sleep disruptions (n)</td>
<td>31 (19)</td>
<td>28 (17)</td>
<td>0.67</td>
</tr>
<tr>
<td>Movements (n)</td>
<td>128 (77)</td>
<td>141 (88)</td>
<td>0.63</td>
</tr>
<tr>
<td>Activity score</td>
<td>9045 (7696)</td>
<td>11073 (5289)</td>
<td>0.51</td>
</tr>
<tr>
<td>Sleep fragmentation (n)</td>
<td>39 (15)</td>
<td>41 (24)</td>
<td>0.84</td>
</tr>
<tr>
<td>Immobility rate &gt;1 min (n)</td>
<td>15 [10 – 20]</td>
<td>15 [8 – 22]</td>
<td>0.92</td>
</tr>
</tbody>
</table>
than the real measured sleep time. This difference may be attributed to the discontinuous method of collection and to an unconscious confidence in actimetry as the gold standard. As it concerned arousals from sleep, the described discrepancy between patients and actimetry measurements suggested unconscious or unmemorized events during the first postoperative night because they were never fully awakened from sleep (Table 2). Noise may have caused arousals with no complete awakening, leading to sleep fragmentation and poor sleep quality as reported by Freeman and colleagues or Balogh and colleagues, with the longest ‘quiet’ interval measuring 22 min.

Actimetry did not show any difference between the two study groups. Several reasons may explain this result. First, the duration of the study (20:00 to 08:00) may have been too short and consequently may not have explored the 24 h period. Previous studies in ICUs have demonstrated that the sleep–wake cycle was redistributed over a 24 h period, with large individual variations in total sleep time.25 Second, actimetry was based on wrist movement, which may have been decreased in the postoperative period because of the supine position, residual sedative agents, and pain. It may have overestimated sleep duration in the control group, mistaking immobility for sleep.

Better preservation of sleep quality may promote cognitive function or pain expression. In a study of 62 critically ill patients, Helton and colleagues noted a direct relationship between sleep deprivation and the occurrence of delirium. This study showed similar results, with a decrease in postoperative disorientation and no cases in the intervention group. This result might be the consequence of a lower consumption of morphine in the intervention group, as known adverse effects of opioids are delirium and sedation. Hence the lower opioid consumption by intervention patients may emphasize the increased comfort and benefit related to eye masks and earplugs. This sparing effect on sleep preservation of opioid consumption should be further explored by other studies. Such a favourable outcome, if confirmed in the elderly, may also reduce the undesirable effects of morphine, including hallucinations and acute urinary retention, with a global improvement in healthcare.

The first limitation of this study remains the absence of determination of the sleep pattern through the analysis of actimetry. In fact, it provides calculation rather than interpretation from a wrist signal and not from electrocortical activity. If no difference is measured, this does not imply a similar sleep pattern. Patients who appear to be asleep can, in fact, have different qualities of sleep. Nevertheless, actimetry is non-invasive and well tolerated by patients and is now a common tool for ambulatory sleep recording and has been validated in comparison with polysomnography. The second limit of this study is the absence of a double-blind, which was not appropriate in this case. Consequently some results have to be analysed with caution. Therefore we cannot exclude a bias in the hetero-evaluation of patients with and without an eye mask as it concerns the state ‘wake’ or ‘awake’, for example. This bias was counterbalanced through a subjective (autoevaluation) and an objective scale (actimetry). Moreover, the nurses’ intervention was strictly limited to care, with minimal interaction with patients in both cases.

In conclusion, sleep quality was significantly preserved by the use of earplugs and eye masks. These simple, cheap, and safe devices are an effective way to improve the comfort and sleep quality of postoperative patients, decreasing their external stimuli perception. Moreover, good acceptance related to self-control makes this method more effective than behavioural changes from caregivers in accordance with a long-term noise prevention policy and could easily be generalized in ICUs, PACUs, or emergency units.

### Supplementary material

Supplementary material is available at [British Journal of Anaesthesia](https://academic.oup.com/bja) online.

### Authors’ contributions

M.L.G.: study design, conduct of the study, data analysis, and manuscript preparation. A.N.-R.: study design and manuscript preparation. C.L.: conduct of the study, data analysis, and manuscript reviewing. I.A.: sleep assessment, actimetry analysis, and manuscript preparation. O.L.: study design and manuscript preparation.

### Declaration of interest

None declared.
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